THE INTERREGIONAL IMPACT OF FEDERAL GRANTS TO PROVINCIAL GOVERNMENTS

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GOVERNMENTS

By

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ABSTRACT

This study develops a methodology to analyze the interregional impact of Federal grants to provincial governments. The approach is an application of Input-Output analysis. The methodology is empirically implemented to illustrate the extent that employment income generated by Federal grants to a province spills over into other regions. These spillovers are recorded at an individual industry level and at the regional level. Four grant programs are investigated. These are equalization payments, and three conditional grants: health, social welfare, and education.

An interregional Input-Output model is developed for sixteen industries in five regions: the Atlantic provinces, Quebec, Ontario, Manitoba, and the United States. For each region, the government sector is specified by five final demand vectors which correspond to the three expenditure categories of the conditional grant programs, transportation-communication, and a general category which includes all other provincial government expenditures. This empirical model is based on three sources: the interregional Input-Output table of Canada developed by the Agricultural Economic Research Council, five provincial government expenditure functions estimated for each Canadian region in the model, and the regional government final demand vectors.

The results indicate that the gross employment income generated by federal grants is partially contained within the region receiving the grant. Ten dollar per capita increases in equalization payments to individual regions generate additional employment income in other regions

which varies from $0.63 to $0.03 per capita. In all cases, these per capita spillovers are less than the per capita employment income generated in the recipient region. For all equalization payments, Ontario received the greatest per capita spillin followed by Quebec. The smallest per capita spillin accrues to either the Atlantic provinces or the United States. In general, this pattern of spillovers reflects the pattern of employment income generated in each industry of these regions as equalization payments are increased. However, exceptions are observed. For example, the spillover to the Quebec leather and textile industry which is generated by the equalization payment to Manitoba is larger than the local employment income effect in this industry.

A similar pattern of regional per capita spillovers is observed for conditional grants. In general, the largest per capita spillovers are generated by conditional health grants.

Overall, the methodology and results indicate how federal grant programs can accommodate interregional spillovers and their consequences for the regional and interindustry distribution of employment income.

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CHAPTER 1

INTRODUCTION

1.1 Nature of the Problem

In the past thirty years, 1947 to 1977, the fiscal structure of Canadian federalism has increasingly emphasized federal grants as a means of financing provincial government expenditure. During this period, the real value of unconditional and conditional grants to all provincial governments has increased markedly.[1] Altogether, these grants comprise 19 percent of total provincial government revenue in 1977. Furthermore, the percentage increase in the real value of these grants has varied considerably between provinces.[2]

These grants are important, since they ultimately affect the level of income accruing to residents in each province. Unconditional and conditional grants are transferred directly to provincial governments and not to the residents of a province. However, these grants have indirect effects on the level of provincial income. This indirect income effect of federal grants is transmitted through the fiscal response of provincial governments to federal grants. This fiscal response may include changes in provincial government expenditure, taxation effort, and/or indebtedness. For example, if a provincial government increases its expenditure, without increasing taxes or borrowing in response to an increase in a federal grant, this provincial fiscal response generates income in the recipient province, and in other provinces which export commodities and services to the recipient province.[3] To the extent that per capita federal grants and provincial fiscal response varies between provinces, different income effects are generated in recipient and non-recipient provinces.

The impact of federal grants on provincial economies has been the subject of recent studies in fiscal federalism. These studies can be categorized into two general subject areas. The first and most common type of study deals with the fiscal response of provincial governments to federal grants (Maley, 1972; Hardy, 1976). The provincial fiscal response to federal grants describes the change in provincial government expenditure which is induced by increases in federal grants. Secondly, economists have analyzed how the magnitude and provincial allocation of federal grants and the per capita income disparities between provinces, are related to the form of the federal grant formulae (Courchene, 1979; Swan, 1977).

In these studies, the provincial distribution of personal income generated by federal grants has not been analyzed. The personal income generated by these grants is comprised of two separate income effects; local and spillover income. Local income is the personal income generated in the province which receives the grant. Spillover income is the direct and indirect personal income which accrues to residents of a non-recipient province. This income is generated as the recipient province imports goods and services from non-recipient provinces. Spillover income effects indicate the extent that benefits of federal grants are lost by the recipient province to non-recipient provinces. Variation in the provincial allocation of per capita federal grants and in the fiscal response of provincial governments to these grants induces diverse local and spillover income effects. These income effects alter the provincial distribution of personal income. In addition to variation in the provincial distribution of personal income, federal grants induce changes in the interindustry distribution of income in each province. The interindustry distribution of income is altered because provincial government expenditure on different programs generated by federal grants varies between industries. Moreover, the industrial composition of provincial government expenditure varies among the provinces. Thus, the provincial allocation of federal grants has an impact on the interindustry and provincial distribution of personal income.

1.2 Objectives of the Study

The major aim of this thesis is to develop a methodology appropriate for analyzing both the local and spillover employment income effects of federal grants. Employment income is the personal income which accrues to labour employed in industries where output is increased as federal grants are increased. The usefulness of this methodology is illustrated in the development of an empirical example of increased federal grants to select Canadian regional governments. In this illustration, the effects of four federal grants on the interindustry and regional distribution of employment income in four Canadian regions and the United States are analyzed. The four Canadian regions included in this analysis are: the Atlantic provinces, Quebec, Ontario, and Manitoba.[4] The analysis demonstrates how the theoretical model of federal grants can be applied empirically.

Specifically, there are four objectives of this study. The first objective is to describe the institutional framework of federal unconditional and conditional grants to the Canadian provincial governments. This discussion, which focuses on the nineteen-year period 1947 to 1965, is presented in Chapter 2.

The second objective of this study is to develop a methodological approach to the analysis of the interindustry and the regional distribution of employment income induced by increased federal grants to regional governments. A regional government is defined as the composite of the provincial governments which have jurisdiction in the economic region. Thus, a regional government is identical to the provincial government if the economic region is made up of only one province; for example, Ontario. Alternatively, the regional government is a combination of several constituent provincial governments if the economic region comprises several provinces; for example, the Atlantic provinces.

For the purpose of analyzing the income effects, two theoretical models of a federal system are developed. In both models, four types of federal grants are considered explicitly: unconditional grants, non-matching conditional grants, open-ended matching grants, and closed-ended matching grants. The first model, which is presented in Chapter 4, is a behavioral model of regional government fiscal response to federal grants. The second model is an interregional Input-Output (I-O)[5] model of regional fiscal policy. This I-O model provides the methodological framework for analyzing the local and spillover income effects of regional government expenditure induced by federal grants. The I-O model does not consider changes in investment, and government taxation or indebtedness as federal grants are increased. Thus, the income effects which are derived using this model represent the short-run or impact effects of federal grants. This model is presented in Chapter 5. Previous approaches to the analysis of fiscal response to federal grants and the I-O analysis of regional fiscal policy are reported in Chapter 3.

The third objective of this study is to illustrate the usefulness of this methodological approach in the context of Canadian federal grants to regional governments. Four federal grants: unconditional grants, conditional health grants, conditional social welfare grants, and conditional education grants, and five regions: the Atlantic provinces, Quebec, Ontario, Manitoba, and the United States, are included in the empirical model. In this discussion, an empirical model of regional fiscal response to the four federal grants is estimated. The empirical example is based on these estimates of regional fiscal response. In addition, a five region, sixteen industry interregional I-O model of the Canadian and United States economies is described. From this I-O model, the local and spillover income effects generated by four federal grants are calculated for the 1965 fiscal year. These empirical models are developed in Chapter 6.

The fourth objective of this study is to analyze the effects of equal per capita increases in each federal grant to the four select Canadian regions on the interindustry and regional distribution of employment income in 1965. In Chapter 7, estimates of the local and spillover employment income effects induced by increases in each grant are discussed.

Chapter 8 presents the conclusions. The usefulness of this methodology is assessed in the light of the empirical results. The implications of this analysis for federal policies which are designed to reduce regional income disparities are explored.

Footnotes to Chapter 1

[1]During the 1947-1977 time period, unconditional and conditional grants have increased by roughly 400 percent and 2500 percent.

[2]The percentage increase in real per capita unconditional grants during the 1947-1977 time period has been roughly 330 percent in the Atlantic provinces, 880 percent in Quebec, and 220 percent in Manitoba. In Ontario, real per capita unconditional grants have decreased by roughly 40 percent during this time period. Similarly, the increases in real per capita conditional grants are roughly 1640 percent in the Atlantic provinces, 1370 percent in Quebec, 1270 percent in Ontario, and 1260 percent in Manitoba. The percentage change in federal grants to Saskatchewan, Alberta, and British Columbia is excluded here because the empirical analysis of federal grants presented in Chapters 6 and 7 is based on an interregional Input-Output model which does not include these provinces.

[3]This income generation represents the impact effects of the federal grants. Specifically, the income effects of federal taxes levied to finance the grant scheme or changes in provincial taxes in response to the receipt of the grants are not considered.

[4]The choice of regions analyzed in this thesis is determined by the availability of data. The interregional I-O table which is employed here includes only these four Canadian regions.

[5]The Input-Output model is denoted by I-O hereafter.

CHAPTER 2

FEDERAL-PROVINCIAL GRANTS, 1947-1965

In this chapter, the Canadian federal grants to the provinces over the 1947-1965 time period are described. This description of federal grants provides an institutional context from which the methodological approach to the analysis of federal grants developed in Chapters 4 and 5 should be viewed. The 1947-1965 time period, is chosen because it corresponds to the data employed in the econometric model of regional government fiscal response to federal grants. The description of federal grants presented here is brief. Other authors have provided a complete and detailed description of the Canadian federal-provincial granting relationship from 1867 to the present (Moore, *et al.*, 1966; Carter, 1971; Maley, 1972; Hardy, 1973; and Courchene, 1979).

For descriptive purposes, federal grants to provincial governments are grouped into two categories: unconditional grants, and conditional grants. *Unconditional grants* are lump-sum transfers from the federal government to a provincial government. The provincial government is completely free to allocate these funds to any provincial program; for example, health programs, according to its own priorities.

Conditional grants are transfer payments from the federal government designed to aid specific provincial government programs. Conditional grants may be further subdivided into three categories:

1. non-matching conditional grants,

2. open-ended matching grants, and

3. closed-ended matching grants.

Considering each conditional grant separately, non-matching conditional grants are lump-sum transfers to provincial governments designed as aid for specific programs. Open-ended matching grants are also transfer payments designed to aid specific provincial programs but require that the provincial government match the federal transfer according to some specific, predetermined matching ratio. This matching grant is open-ended to the extent that the federal government will provide funds as long as the provincial government satisfies this requirement. Closed-ended matching grants are similar to open-ended conditional matching grants to the extent that expenditure from federal funds must be accompanied by complementary provincial expenditure. Conditions of the closed-ended grant, however, limit federal transfers to some predetermined value which is less than total provincial expenditure on the aided programs.[1]

The remainder of this chapter is organized as follows: unconditional grants and conditional grants from 1947 to 1965 are discussed in Sections 2.1 and 2.2 respectively. Factors contributing to the trend toward consolidated fiscal power at the federal level are presented in Section 2.3, the conclusion.

2.1 Unconditional Grants

Consider the federal unconditional grants to provincial governments during the time period 1947-1965. Within the unconditional grants category, four major legislative granting schemes were present:

1. Federal-Provincial Fiscal Acts,
2. University Grants,
3. Statutory Subsidies, and
4. Income Tax on Power Utilities.

Each of these major granting schemes will be discussed in order. A more detailed discussion of federal-provincial fiscal relations during the period 1947-1967, is found in Moore, Perry and Beach (1966).[2]

2.1.1 Federal-Provincial Fiscal Acts

First, consider the Federal-Provincial Fiscal Acts. Four Federal-Provincial Fiscal Acts were effective over the period 1947-1965:

1. Tax Rental Agreement Act 1947,
2. Tax Rental Agreement Act 1952,
3. Federal-Provincial Tax-Sharing Arrangements Act 1956, and
4. Federal-Provincial Fiscal Arrangements Act 1961.

As the 1947 and 1952 Acts are very similar, they are discussed jointly. The 1957 and 1961 Acts are discussed separately. In Table 2.1 per capita federal unconditional grants for selected years are presented.

Tax Rental Agreements Acts 1947 and 1952

The Tax Rental Agreements Acts 1947 and 1952 authorized the federal government to make tax-rental agreements with the provinces. Participating provinces agreed to vacate the individual income tax, corporate tax, and succession duties fields in lieu of transfer payments from the federal government.

The formula used to calculate transfers under these Acts included certain equalization features. Actual transfers to provinces were based

TABLE 2.1

UNCONDITIONAL GRANTS PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$44.13	$42.78	$81.09	$89.51
Prince Edward Island	31.82	38.04	75.40	95.35
Nova Scotia	23.60	34.97	57.41	66.76
New Brunswick	25.62	35.39	59.28	72.86
Quebec	0.94	0.95	12.57	30.18[b]
Ontario	0.92	30.32	20.10	3.34[c]
Manitoba	25.58	35.14	45.95	31.56
Saskatchewan	24.45	33.56	46.16	32.78
Alberta	23.23	36.50	46.95	7.89[c]
British Columbia	27.93	41.15	47.03	1.65[c]

[a] Source: Maley (1972, p. 20).

[b] In 1965, Quebec began to receive additional unconditional grants as compensation for opting out of certain conditional grant programs.

[c] After 1964, provincial natural resource revenues above the national level were deducted from the provinces equalization payment.

on "guaranteed minimum annual amounts" or "guaranteed minimum payments". Under the 1947 Act, the guaranteed minimum annual payment was based on three factors: (1) a per capita payment based on provincial population in 1942, (2) statutory provincial subsidies, and (3) provincial revenue from the three vacated tax fields. This guaranteed minimum amount was adjusted by two factors: (1) the proportional change in provincial population since 1942, and (2) the proportional change in per capita Canadian Gross National Product since 1942.

The guaranteed minimum payment under the 1952 Act was determined by the same factors as the 1947 Act, but the form of the equalization formula differed from that specified in the 1947 Act. This "payment" was then adjusted by the same ratios as in the 1947 Act but based on 1948 per capita Gross National Product and provincial population rather than 1942 quantities. In contrast to the 1947 Act in which the adjusted annual amount was an average of the appropriate amount over the three preceding fiscal years, provinces had the option, under the 1952 Act, of calculating this amount according to: (1) the amount for the year immediately preceding the given year, or (2) the average of the amounts over the two preceding years.

No provision was made in the Acts for transfer payments to provinces that did not agree to vacate the three specified tax fields. For this reason, Ontario and Quebec did not receive federal grants under the 1947 Act and Quebec did not receive a grant under the 1952 Act.

Under both acts, provision for federal tax abatements in the three vacated fields was made to avoid double taxation in provinces not agreeing to vacate the tax fields. The federal individual income tax abatement was five percent of federal individual income tax payable from 1947 to 1953 and ten percent of federal individual income tax payable from 1954 to 1956. Quebec, the only province to take advantage of this abatement scheme, did not levy a provincial individual income tax until 1954. The federal corporation income tax abatement scheme was slightly more complicated. Under the 1947 Act, agreeing provinces were required to levy a five percent corporation income tax, so non-agreeing provinces could levy a similar tax. Under the 1952 agreement, the federal government increased its corporation income tax rate five percent and corporations in non-agreeing provinces were allowed a federal income tax credit of up to five percent of the corporation taxable income. Agreeing provinces completely vacated the corporation income tax field under this agreement.

Both Ontario and Quebec levied their own succession duties from 1947 to 1956.

1956 Tax Sharing Arrangements Act

In 1956 a new Federal-Provincial Tax Sharing Arrangements Act became effective. The separation of "pure" tax-rental payments and provincial equalization payments was the significant change in the 1956 Act. With this separation, less importance was attributed to the tax-rental agreement. Provinces that did not enter into tax-rental agreements with the federal government were more generously treated.

A series of standard taxes and standard tax rates was the foundation of the tax-rental and equalization payments of the 1956 Act. The standard taxes were defined as:

1. a personal income tax equivalent to ten percent of the federal income tax payable in the province less Old Age Security Tax,

2. a corporation income tax equivalent to nine percent of the corporation income generated in the province, and

3. succession duties equivalent to 50 percent of the succession duties payable to the province.

By this Act, the federal government was authorized to make tax-rental payments to provinces which vacated the income tax field, both individual and corporate, and succession duties field. Tax-rental payments were the sum of three components: (1) the standard individual income tax; (2) the standard corporation income tax; (3) the average standard succession duties over the current fiscal year and the two previous fiscal years.

All provinces except Ontario and Quebec vacated the specified tax fields. Ontario vacated only the individual income tax field while Quebec did not sign any agreement. To alleviate double taxation in Ontario and Quebec, a federal tax abatement was granted. For each tax field these abatements were (1) the smaller of two amounts: other provincial personal income tax paid or ten percent of federal personal income tax; (2) nine percent of the federal corporation income tax base; and (3) fifty percent of the federal succession duties.[3]

The tax revenue equalization payment made to province k in any given fiscal year was determined by equations (2.1a) and (2.1b),

$$\text{(2.1a)} \qquad TE^k = \frac{1}{2}\left(\frac{ST^m}{P^m} + \frac{ST^s}{P^s}\right) - \frac{ST^k}{P^k}$$

and

$$(2.1b) \quad TE^k \geqslant 0$$

where TE^k is the tax equilization payment to province k;

ST^i, i = k, m, s, is the revenue from the three standard taxes in province i;

P^i, i = k, m, s, is the population of province i; and

m and s are the two provinces for which the per capita standard taxes were the greatest.[4,5]

This formula equalized provincial revenues according to fiscal capacity. If the calculated tax equalization payment to province k, TE^k, was negative, the provincial government did not receive a grant. This condition is stated in equation (2.1b).

The Act also authorized the federal government to make a separate stabilization payment. This payment was designed to raise provincial yield from the equalization payment and standard taxes to the minimum of:

1. the previous federal arrangements extended to current years;

2. the last payment under the previous arrangements adjusted for population changes; or

3. 95 percent of the average payments for the previous two years under the 1956 Act.[6]

Amendments to the 1956 Tax Sharing Arrangements: In 1958, the Act was amended. Changes included increasing the standard tax rate and federal abatements on individual income tax to 13 percent.

Federal-Provincial Fiscal Arrangements Act 1961

The Federal-Provincial Fiscal Arrangements Act was passed in 1961. Under this Act, the federal government undertook to withdraw from tax-rental agreements with the provinces except in the field of succession duties to increase provincial "tax room". The federal withdrawal equalled nine percent of corporation income tax payable and 16 percent of federal individual income tax payable. Abatement in the individual income tax field was scheduled to increase at a rate of one percent per annum to a maximum of 20 percent in 1966. As previously calculated, the abatement applied to federal individual income tax payable, excluding the Old Age Security Tax.

The federal government was also authorized to offer to collect, without charge, any income taxes levied by the provinces where the provincial tax base was identical to the federal tax base. Six provinces set their tax rate at the same level as the federal abatement. Saskatchewan and Manitoba adopted higher corporation and individual income taxes. Ontario levied an individual income tax equal to the federal abatement while adopting a higher corporation income tax rate. Throughout the period Quebec retained its corporation and individual income tax rates already in effect at the time of the new agreement. Quebec was the only province which did not enter into a tax collection agreement with the federal government.

The 1961 Act also authorized the federal government to make the following payments to all provinces:

1. succession duty payments,
2. tax-rental equalization payments, and

3. provincial revenue stabilization payments.

The equalization payments authorized in the 1961 Act were based on more provincial revenue sources than the 1956 equalization payments. Under the 1961 Act three standard tax revenues and natural resource revenues were equalized. Definitions of the standard taxes were the same as the 1956 Act except for the individual income tax which was equivalent to 19 percent of federal income tax payable in 1962 increasing to 25 percent of federal income tax payable in 1966. The concept of federal income tax payable excludes the Old Age Security Tax and is not of the provincial individual income tax abatements.

The equalization payment to province k was determined by equations (2.2a) and (2.2b),

$$(2.2a) \qquad TE_t^k = \frac{1}{P_t} \cdot \frac{1}{10} \sum_{m=1}^{10} [ST_t^m + .5(\frac{1}{3} \sum_{h=t-1}^{t-3} R_h^m)] - \frac{1}{P_t^k}[ST_t^k + .5(\frac{1}{3} \sum_{h=t-1}^{t-3} R_h^k)]$$

and

$$(2.2b) \qquad TE^k \geq 0$$

where R_h^m is the natural resource revenue in province m in year h;

P is the total population in all ten provinces; and

subscript t denotes time.

All other variables have been defined with respect to equations (2.1a) and (2.1b). If the calculated equalization payment to province k, TE^k, was negative, the provincial government did not receive a grant. This condition is summarized in equation (2.2b).

This grant formula equalized provincial revenue according to fiscal capacity. The inclusion of a three-year moving average of gross provincial natural resource revenue increased the fiscal capacity index. In addition, the increased number of equalized revenue sources and the new definition of the revenue-raising criterion based on all ten provinces augment the stabilizing effects of the grant. Neither requirement for stabilizing revenue equalization was incorporated in previous Acts.

In addition to these implicit stabilization features the federal government guaranteed that:

1. no province entitled to equalization would receive less than it would have received under a continuation of the old equalization formula and tax rental arrangement, and

2. no province would receive less than it had received on the average in the final two years or in the final year of the old arrangements.[7]

Stabilization payments under the 1961 Act were granted to provinces where the annual yield from standard taxes and equalization payments fell below 95 percent of their average receipts for tax rental, equalization and stabilization payments of the preceding years.

Amendments to the 1961 Fiscal Arrangements Act: The Federal-Provincial Arrangements Act 1961 was amended by the Federal-Provincial Fiscal Revision Act, 1964. By this amendment the standard individual tax rate for the years 1965 and 1966 was increased.[8] Also, the federal government was authorized to increase succession duty payments to

75 percent of federal estate duties. However, this additional 25 percent was not to be equalized.

In addition, a revised equalization payment formula was introduced. This new formula is summarized by equations (2.3a) and (2.3b),

$$(2.3a) \qquad TE_t^k = \frac{1}{2}\left(\frac{ST_t^m}{P_t^m} + \frac{ST^s}{P_t^s}\right) - \left(\frac{ST_t^k}{P_t^k} - .5\left(\frac{P_t^k}{3} \sum_{h=t-1}^{t-3} \left[\frac{R_h^k}{P_h^k} - \frac{1}{10} \sum_{m=1}^{10} \frac{R_h^m}{P_H^m}\right]\right)$$

and

$$(2.3b) \qquad TE_t^k \geq 0.$$

No additional revenue sources were included in this revised equalization formula. In addition, the revenue raising criterion in the standard tax fields was based on a reduced number of provinces. The inclusion of provincial population, P_t^k, in the natural resource component of the equalization formula provides an implicit index of provincial expenditure needs. Deviations of provincial per capita natural resource revenues from the mean for all provinces were weighted by provincial population. This was advantageous only to provinces having low natural resource revenue.

Conclusion

Over the time period covered in this section, 1947-1965, several patterns of future Federal-Provincial Fiscal Relations emerged. Some of these patterns are: (1) the federal government's withdrawal from tax-rental agreements and recognition of the right of all low-income provinces to equalization payments, (2) an increased number of revenue sources equalized, and (3) equalization based on a fiscal need and fiscal capacity basis.

2.1.2 Statutory Subsidies

A second category of federal unconditional grants to the provinces was statutory subsidies. Statutory subsidies are federal unconditional grants authorized by statutes other than the Federal-Provincial Fiscal Relations Acts. The major grants in this area were:

1. British North America Act 1867, 1907,
2. University Grants,
3. Acts Relating to Newfoundland, and
4. Atlantic Provinces Adjustment Grants.

British North America Act

Consider first the British North America Act 1867, 1907. Amending the British North America Act of 1867 this Act provided for revenue equalizing grants to the provinces based on expenditure need defined as provincial population.

University Grants

Also based on expenditure need, were annual grants instituted in 1951 to support universities. Prior to 1957 the aggregate annual amount of each provincial grant was fifty cents per capita. In both 1957 and 1958 the grants increased by fifty cents per capita.

Between 1951 and 1960 Quebec universities accepted these grants only for the 1951 fiscal year. The Federal Provincial Tax Sharing Arrangement, 1957 was amended in 1960 to permit Quebec to collect an extra one percent corporation income tax in lieu of university grants. A federal corporation income tax abatement of one percent on corporation income in Quebec was also introduced to avoid double taxation.

Quebec's equalization payments were adjusted accordingly to ensure that Quebec received payments equivalent to those available if it had accepted university grants.

University grants were increased to two dollars per capita in 1962. The corporation tax abatement which compensated Quebec was not adjusted for these increases. In lieu of compensation, additional funds were transferred to Quebec in the 1966 fiscal year.

Although such tax abatement schemes appear as relatively minor items in federal-provincial fiscal relations, they establish a precedent for further withdrawal from grant programs.

Acts Related to Newfoundland

The rationale for the Acts Relating to Newfoundland and the Atlantic Provinces Adjustment Grants was the generally low fiscal capacity of the Atlantic Region. Consider the Acts Relating to Newfoundland. In 1949, the federal government agreed to the following annual payments to Newfoundland:

1. the same subsidies as those to other provinces under the British North America Act 1867, 1907;

2. a $1,100,000 additional subsidy; and

3. a transitional grant of $6,500,000 in 1949 decreasing annually to $350,000 in 1960.[9]

By the Newfoundland Additional Grants Act, 1959,[10] the federal government was authorized to subsidize Newfoundland at a rate of eight million dollars per annum. Until 1961, these subsidies consisted of the previously discussed transitional grants, and the balance of eight million dollars.

Atlantic Province Adjustment Grants

Atlantic Province Adjustment Grants began under the 1958 amendment to the Federal-Provincial Tax Sharing Arrangements Act of 1956. Under this arrangement, the federal government was authorized to pay 25 million dollars annually to the Atlantic Provinces. One-tenth of the annual payment was transferred to Prince Edward Island while the remainder was divided equally among Newfoundland, Nova Scotia, and New Brunswick. In the 1962 Federal-Provincial Fiscal Arrangements, this grant was increased to 35 million dollars. It is worth noting, again, that these grants are based on fiscal capacity unlike the grants authorized under the British North America Act or the University Grants.

2.1.3 Income Tax on Power Utilities

Since 1947 the federal government has transferred to the provinces 50 percent of federal income tax collected from corporations engaged in the generation and/or public distribution of electricity, gas, or steam. In calculating this transfer, revenue from the Old Age Security Tax is excluded from federal corporation income tax. These transfers continued until 1965 when the federal government increased the payment to 95 percent of collections. One disadvantage of this type of transfer is the long lag, three years in this case, required to calculate the amount of the payment.[11]

2.2 Conditional Grants

Conditional grants from the Canadian federal government to provincial governments increased considerably between 1947 and 1965. In 1947 the grants program comprised two major schemes in the field of social welfare,[12] and one scheme concerning education.[13] The growth in the absolute and relative importance of conditional grants resulted from two developments:

1. The federal government preferred to coordinate and stimulate uniform provincial programs by strong revenue collection and expenditure controls acquired during W.W. II. Thus, it emphasized conditional grant programs at the expense of unconditional grants and granting additional provincial "tax room".[14]

2. As tax rental programs were replaced by provincial levies in the major tax fields, conditional grants gradually dominated federal-provincial transfer programs.

These issues are implicitly illustrated in Table 2.2 where the percentage of total federal transfers to the provinces through conditional grants is illustrated for selected years.

TABLE 2.2

CONDITIONAL GRANTS AS A PERCENTAGE OF TOTAL FEDERAL PAYMENTS TO THE PROVINCES, SELECTED YEARS[a]

Year	As Percentage of Total Federal Payments to Provinces
1953	18.1
1956	20.7
1960	42.6
1964	77.1

[a] Source: Carter (1971, p. 25).

Five conditional grant programs: Health, Social Welfare, Education, Transportation and Communication, and Natural Resource and Primary Industry development are described.

2.2.1 Health Grants

Federal grants to assist provincial provision of health programs have continued since 1919, although it was only in 1948 that a comprehensive national health program was begun. This national health program was coordinated and financially assisted by federal grants under the National Health Program. In addition, federal assistance in the provision of hospital insurance and diagnostic services by provincial governments was initiated under the Hospital Insurance-Diagnostic Services Act, 1957. Each of these health grants is now described.

The National Health Care Program

First, consider the National Health Program. The objective of the National Health Program was to extend and improve services in specific health services. The original grants of this program were directed at ten health areas: a health survey,[15] general public health, tuberculosis control, mental health, venereal disease control, crippled children, professional training, public health research, cancer control, and hospital construction.[16] In 1953 three additional grants were introduced: laboratory and radiological services grants, medical rehabilitation grants, and child and maternal health grants. With these amendments, hospital construction grants were reduced by 50 percent. Anticipating increased demand for medical services after introduction of the hospital insurance plan, hospital construction grants were later increased on January 1, 1958 from $1,000 to $2,000 per head.[17] However, total federal contribution to hospital construction was limited to one-third of the cost of any project.

With general provincial acceptance of the hospital insurance program, the National Health Grant program was further amended in 1960. The changes were intended to satisfy more adequatly current needs in specific health areas and facilitate integration of the federal administration of health grants with provincial hospital insurance programs. Specific changes to the program included incorporating the Venereal Disease Control Grant, the Crippled Children's Grant, and the Laboratory and Radiological Services Grant into more comprehensive programs. Venereal disease control and laboratory and diagnostic services not covered under the Hospital Insurance and Diagnostic Services Act were included in the expanded General Public Health Grant. The Crippled Children's Grant was incorporated into the Medical Rehabilitation Grant.

In summary, most National Health Grants were non-matching conditional grants. The majority of payments were either fixed sums or allocated on a per capita basis.[18] Only the Public Health Research Grant, the Hospital Construction Grant, and the Cancer Control Grant were matching conditional grants.[19]

Hospital Insurance-Diagnostic Services

Second, consider the Hospital Insurance and Diagnostic Services Act. The Hospital Insurance and Diagnostic Services Act, 1957 became effective in 1958; however, all provinces did not participate in the scheme until 1961.

The costs shared with the federal government include those incurred by insured patients for a specific bundle of in-patient services and by any out-patient services a province wishes to provide as insured services.[20] The Act did not provide a cost sharing arrangement for services to which any person is entitled under any other federal or provincial act specified in the agreement. Such Acts include workers compensation, veterans schemes, hospitals or institutions for the mentally ill, nursing homes, homes for the aged, or services in tuberculosis hospitals and sanitoria.[21]

The annual contribution of the federal government to the health insurance scheme was the sum of two components: (1) 25 percent of the national per capita cost of in-patient services, and (2) 25 percent of the province's per capita cost of any approved patient services less any deterrent charges levied. This sum is then multiplied by the annual average number of insured persons in the province. As a result of this formula low-cost provinces were compensated for a greater percentage of their total expenditure than provinces where health care costs were greater than the national average. This trend is illustrated in Table 2.3 in which the federal contribution to the cost of hospital care is shown.

Freedom to choose their own methods of financing the provincial share of this program has resulted in a wide range of provincial financing arrangements.[22]

Since obligations were not limited under this scheme to any maximum amount, the Hospital Insurance and Diagnostic Services Act can be considered an open-ended matching conditional grant program.

TABLE 2.3

FEDERAL SHARE OF THE HOSPITAL INSURANCE AND DIAGNOSTIC SERVICES PROGRAM[a], 1958-1965[b]

Province	1958	1959	1960	1961	1962	1963	1964	1965
Newfoundland	63.6%	62.8%	63.4%	65.8%	66.5%	65.7%	60.3%	55.5%
Prince Edward Island	----	57.6	52.6	50.2	53.1	62.0	62.0	63.4
Nova Scotia	----	54.8	53.1	53.2	54.1	54.5	54.4	54.8
New Brunswick	----	53.0	44.7	49.3	49.6	50.6	50.6	52.2
Quebec	----	----	----	54.6	52.8	51.3	55.5	49.1
Ontario	----	44.5	44.5	45.5	46.3	47.1	47.5	48.1
Manitoba	49.3	47.1	47.4	48.7	49.6	50.1	51.6	52.2
Saskatchewan	40.6	41.8	43.0	44.1	45.2	46.6	47.4	48.2
Alberta	25.5	43.2	43.5	44.9	45.8	46.6	46.8	48.7
British Columbia	44.6	45.4	46.1	47.1	48.6	49.6	51.6	52.6

[a] Source: Maley (1972, p. 54).

[b] Calendar years.

The per capita value of federal health grants for selected years is listed in Table 2.4.

2.2.2 Social Welfare Grants

Federal grants in the social welfare area originated with the Old Age Pension Act 1927. This Act provided federal payments of half the costs incurred by provincial governments in the provision and administration of pension plans. In 1931, the federal contribution was increased to pay three-quarters of these costs. By 1936, all provinces were participating in the program. A 1937 amendment provided pensions for blind persons 40 years of age and over. Throughout the next decade, monthly pensions for the blind were progressively increased and the age requirement was gradually reduced.

The Old Age Pension Act was disaggregated in January 1952 to accommodate separate and differential coverage of particular aid categories. Three new Acts, the Old Age Security Act, the Old Age Assistance Act, and the Blind Persons Act, superseded the Old Age Pension Act. All provinces entered into cost sharing agreements with the federal government under the Blind Persons Act and the Old Age Assistance Act.[23] By the Old Age Assistance Act, 1952, the federal government paid 50 percent of provincial assistance payments to persons 65 years of age and over who were not eligible to receive Old Age Security Payments.[24] Under the Disabled Persons Act, January 1955, the federal government agreed to pay half the provincial allowances to totally disabled persons 18 years of age and over who satisfied residency and income requirements.

TABLE 2.4

FEDERAL CONDITIONAL HEALTH GRANTS PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$1.99	$2.42	$16.17	$27.90
Prince Edward Island	2.37	3.44	15.55	27.41
Nova Scotia	1.97	2.58	19.73	28.63
New Brunswick	2.11	3.46	19.45	26.50
Quebec	1.77	2.14	16.86	.94
Ontario	1.47	1.85	18.83	27.16
Manitoba	1.37	3.05	19.10	26.93
Saskatchewan	1.92	2.28	19.86	30.10
Alberta	1.81	2.38	16.53	27.91
British Columbia	2.33	2.28	18.10	25.11

[a] Source: Maley (1972, pp. 187-192).

In 1956 the Unemployment Assistance Act was passed committing the federal government to sharing, on a matching basis, provincial costs of assistance to needy "unemployed employables". The province alone was relegated responsibility for assistance to unemployables. The federal government agreed to share assistance costs only for the needy unemployables in excess of 0.45 percent of the provincial population.[25] Federal assistance was extended to all unemployables in 1957 after several provinces, unable to agree upon definitions of employable and unemployable persons, refused to participate in the program. Under the 1957 program, provincial governments determined both rates of payment and conditions of payment. Prior to its absorption into the Canadian Assistance Plan, the Act also authorized federal payments of half the supplementary aid to recipients of old age security pensions, old age assistance, unemployment insurance benefits, and allowances to the blind and disabled.

The per capita value of the conditional social welfare grants is listed in Table 2.5.

2.2.3 Education Grants

In addition to federal unconditional grants for education, university grants, the federal government has entered into several closed- and open-ended conditional matching grant agreements with the provinces to finance technical and vocational training programs.

Federal grants to stimulate provincial expenditure on technical and vocational training programs began in 1919 when the Technical Education Act was passed. This grant program was subsequently extended in 1939 when a program for training employed youth was initiated, and in

TABLE 2.5

FEDERAL CONDITIONAL SOCIAL WELFARE GRANTS
PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$8.86	$7.00	$13.46	$16.21
Prince Edward Island	7.99	3.08	6.94	11.70
Nova Scotia	8.45	2.27	6.13	8.15
New Brunswick	9.01	3.34	7.34	8.39
Quebec	5.17	2.56	9.96	1.75
Ontario	5.35	1.31	4.87	6.94
Manitoba	6.26	1.67	7.11	9.22
Saskatchewan	5.76	2.63	6.87	8.15
Alberta	6.58	1.59	5.32	10.12
British Columbia	7.29	3.09	11.21	13.40

[a] Source: Maley (1972, pp. 187-192).

1942 when a more comprehensive program including apprenticeship training was introduced. Although amended, these programs continued relatively unchanged until the 1960 Vocational Training Assistance Act.

Reflecting the high unemployment rates of unskilled workers in the late 1950's, the Vocational Training Assistance Act was intended to encourage expansion and intensification of provincial facilities to train technicians and technologists. The federal government reimbursed the provinces 50 percent of all program costs. As an extra incentive, federal reimbursement of provincial capital outlays on training facilities increased from 50 percent to 75 percent for expenditures incurred before April 1, 1963. The federal government also paid 50 percent of provincial financial assistance to trainees and 90 percent of the living allowances paid to unemployed persons who were being trained.

In summary, grants for vocational and technical training are open-ended matching conditional grants. The matching ratio for these grants ranges from 50 to 90 percent of provincial costs. The per capita value of these grants for selected years is listed in Table 2.6.

2.2.4 Transporation and Communication Grants

The primary act authorizing conditional grants to provincial governments for transportation and communication was the Trans-Canada Highway Act, 1949. The Act authorized payment of 150 million dollars to cover 50 percent of the construction costs over a six-year period.[26] In 1956, the federal government agreed to pay 90 percent of the costs of constructing ten percent of the highway's total length in a province. This agreement also extended the construction

TABLE 2.6

FEDERAL CONDITIONAL EDUCATION GRANTS PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$0.17	$0.97	$6.45	$8.29
Prince Edward Island	0.01	0.33	2.41	3.59
Nova Scotia	0.39	0.65	1.72	2.72
New Brunswick	0.53	0.43	3.09	4.72
Quebec	0.26	0.14	1.95	5.09
Ontario	0.29	0.27	1.60	7.99
Manitoba	0.35	0.38	0.79	3.85
Saskatchewan	0.50	0.35	1.55	3.02
Alberta	0.33	0.45	1.54	10.54
British Columbia	0.20	0.31	1.68	10.99

[a] Source: Maley (1972, pp. 187-192).

period to December 31, 1960 and increased the total federal contribution to 250 million dollars. Provinces which had delayed highway construction altogether or had postponed construction of costly sections of the highway benefited most from this provision. Further amendments in 1963 raised the maximum contribution of federal funds to 400 million dollars and enabled the federal government to assume 90 percent of highway construction costs. As well, the construction period was extended to December 31, 1967.

A number of minor transportation-communication programs also existed. These programs typically served narrow purposes; for example, the trunk highway program, in only one or a few provinces.[27]

It is obvious from this discussion that the Trans-Canada Highway grants are closed-ended matching conditional grants. Federal transportation and communication grants, during selected years, are presented in Table 2.7.

2.2.5 Natural Resources and Primary Industry Grants

During the period 1947-1965, federal conditional grants for natural resources and primary industry were disaggregated into four areas: agriculture, fish and game, forestry and rural development, and water resources. Grants for these expenditure areas vary in both nature and duration, thus they will be briefly discussed in very general terms.

Consider first the provincial agriculture programs which were aided by the federal government during the period 1947-1965. The most important of these aid programs are:

TABLE 2.7

FEDERAL CONDITIONAL TRANSPORTATION AND COMMUNICATION GRANTS PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$2.74	$ 2.74	$ 4.84	$49.38
Prince Edward Island	0.07	12.44	12.30	26.03
Nova Scotia	0.00	2.28	3.02	12.81
New Brunswick	2.14	6.41	7.95	26.00
Quebec	0.03	0.02	0.83	6.69
Ontario	1.09	0.95	2.67	0.75
Manitoba	0.99	3.66	2.67	1.06
Saskatchewan	1.22	3.23	1.28	0.94
Alberta	0.86	1.20	1.88	0.30
British Columbia	2.44	5.21	8.52	1.29

[a] Source: Maley (1972, pp. 188-191).

1. 4-H Club activity grants established in 1900,

2. freight assistance established in 1946 for livestock shipments to the Royal Winter Fair,

3. special fairs grants established in 1957,

4. rabies control compensation established in 1959,

5. crop insurance grants established in 1961,

6. Agriculture and Rural Development Grants (ARDA) established in 1952, and

7. barberry eradication grants established in 1967.

Under the Crop Insurance Act, 1961, the federal government was authorized to assist provincial financing of crop insurance schemes. The federal government contributed half the administration costs and half the premium costs incurred by the provincial government up to a maximum of 20 percent of these premium costs.

All agriculture grants except special fairs grants, ARDA, and crop insurance grants, were open-ended matching grants.

Federal grants for fish and game were small, typically serving a restricted purpose in only one or a few provinces. One of the most universal programs was the Industrial Development Service. Under this program, federal-provincial cost sharing arrangements, coordinated by the Fisheries Department, financed development programs in the Atlantic provinces and Quebec. Research into fishing techniques and related sciences was conducted under this program. Several of the shared cost wildlife conservation projects were arranged between federal and provincial governments during the 1947-1965 period.

Between 1947 and 1965, considerable federal financial aid to rural development was available through the following programs:

1. forest access roads under the Winter Works Program,
2. forest inventory programs,
3. tree diseases in the forests of New Brunswick and Quebec, and
4. the ARDA agreements.

Federal grants for forestry expenditures began in 1952 when the federal government assumed half the costs of creating and maintaining inventories of forest resources. Provision for federal payment of approximately 20 percent of reforestation costs of unoccupied Crown lands was also included in this agreement.[28] In one section of the 1957-58 Winter Works Program, the federal government agreed to pay half the provincial costs of providing forest access roads for fire protection and other aspects of forest management. This forest program became a year-round program in 1960.

In April, 1962, all federal-provincial forestry agreements were combined and additional federal assistance for stand improvement was provided. The size of the grant to each province depended upon the productive forest area in the province. Under this arrangement, a minimum of 40 percent of the grant was allocated to forest access programs.

The Agricultural Rehabilitation and Development Act (ARDA), which covered the period from April, 1962 to March, 1965, was designed to rehabilitate rural lands and develop the rural economy. Under this Act, the federal government agreed to pay half the provincial costs incurred by eligible projects:

1. for the alternative use of farmland classified as marginal or low productivity;

2. for the development of income and employment opportunities for rural areas; and

3. for the development and conservation of Canadian water and soil resources.[29]

Federal grants from several sources assisted in the development of water resource programs. Under a 1961 federal-provincial program, the federal government contributed to provincial costs incurred in the construction of dams and other works needed to control water resources. The federal government is also involved in matching conditional grants-in-aid programs to finance provincial research, regional planning investigations, and water resource inventories.[30] Federal conditional grants for provincial primary industry and natural resource programs, for selected years, are presented in Table 2.8.

2.3 Conclusion

The preceding discussion has reviewed the important events necessary for understanding the institutional structure of federal-provincial fiscal relations during the period 1947-1965. In studying this institutional material, a trend toward consolidation of fiscal power at the federal level is apparent. Two factors contributed to this trend:

1. there was a strong public demand for a large number of government financed programs; and

2. federal control of the lucrative income tax fields enabled federal financing of these new programs.

TABLE 2.8

FEDERAL CONDITIONAL PRIMARY INDUSTRY-NATURAL RESOURCE DEVELOPMENT GRANTS PER CAPITA IN SELECTED YEARS[a]

Province	1951	1956	1961	1965
Newfoundland	$0.00	$0.31	$0.77	$ 1.72
Prince Edward Island	4.34	0.55	3.08	3.24
Nova Scotia	0.46	0.20	0.84	2.56
New Brunswick	0.17	1.29	1.62	3.29
Quebec	0.16	0.08	0.68	2.16
Ontario	0.01	0.15	0.19	1.02
Manitoba	0.00	0.23	0.64	10.38
Saskatchewan	0.04	0.10	1.03	3.32
Alberta	0.13	0.09	1.02	0.93
British Columbia	0.22	0.62	1.16	1.50

[a] Source: Maley (1972, pp. 188–191).

This trend was manifested in the federal government's shift in emphasis from unconditional grants to conditional grants. This shift in federal-provincial fiscal arrangements was evident from the late 1950's through 1965.

Specific provincial programs financed through conditional grants were an alternative means to enable the federal government to reinforce this trend. Many new programs financed during this 19 year period under conditional grants were in areas of previously exclusive provincial jurisdiction for example, education, social welfare, and natural resources. A more complete discussion of these trends and summary of provincial dissatisfaction with conditional grants and the design of specific grants are found in Chapter 6 of Carter (1971) and Courchene (1979).

The centralist tendencies of the federal government were somewhat relaxed by the contracting-out agreements of 1965. A complete description of these agreements and their evolution is found in Chapter 5 of Carter (1969), <u>The National Finances 1976-1977</u> (1977), and Courchene (1979).

Footnotes to Chapter 2

[1]A non-matching conditional grant is a special case of a closed-ended matching grant where the matching ratio is unity.

[2]Much of the material contained in this section is based on Moore, Perry, and Beach (1966).

[3]The National Finances 1963-64, (Canadian Tax Foundation, Toronto, 1963), p. 110.

[4]Ibid.

[5]For provinces which did not vacate the specified tax fields, ST^k was calculated as the federal tax abatements for that province.

[6]The National Finances 1963-64, p. 110.

[7]The National Finances 1965-66, (Canadian Tax Foundation, Toronto, 1965), pp. 128-129.

[8]In conjunction with this amendment, the Income Tax Act was amended. Federal individual income tax abatements were increased by two percent for taxation year 1965 and five percent for taxation year 1966.

[9]Revised Revenue Statistics, 1952, (Queen's Printer, Ottawa, 1952).

[10]Statutes of Canada, 2nd session, 24th Parliament, 7-8 Elizabeth II, 1959, (Queen's Printer, Ottawa, 1959).

[11]National Finances 1965-66, pp. 129-130.

[12]These grants were intended to support old age pensions and blind persons allowance.

[13]The educational grants were given to support vocational and technical education.

[14]Moore, Perry and Beach (1966), p. 112.

[15]The health survey grant was a non-recurring grant designed to evaluate health service needs in individual provinces and assist in efficiently organizing other health programs.

[16]A universal constraint common to all health grants was that the province would at least maintain the same level of each health service.

[17]The terms of the Hospital Construction Grant Program were extended to include hospital renovation, beds in nurses' residences and accommodation for interns.

[18]Payments for Tuberculosis control were partially based on the incidence of TB deaths. Payments for child and maternal health were based on a flat grant plus the ratio of infant births to infant deaths in the province.

[19]Medical rehabilitation grants can be considered as partially matching as new and extended services are aided by matching grants.

[20]These services vary widely between provinces. For a detailed description see Annual Report on the Operation of Agreement with the Provinces Under the Hospital Insurance and Diagnostic Services Act, (Department of Health and Welfare, Queen's Printer, Ottawa, Annual).

[21]This is not correct in all provinces. For example Ontario's health insurance scheme includes services in Mental hospitals, nursing homes and home care (with a 3.5 dollar fee per day), and tuberculosis sanitoria.

[22]For a statement of provincial health insurance financing schemes see Carter (1971), p. 34.

[23]The provincial government was given the option of transferring blind recipients, upon reaching the age of 70 years, to the Old Age Assistance Program. No province exercised this option because of the differential matching ratio between the two programs. The age requirement for receipt of assistance under the Blind Persons Act is 18 years of age.

[24]The Old Age Security Act provided for a Federal Pension of 40 dollars per month for all residents of Canada 70 years of age and over.

[25]This figure was based on estimates which showed that the number of unemployable constituted 0.45 percent of the national population. See Carter (1971), p. 39.

[26]Under the Trans-Canada Highway Act 1946, the federal government also agreed to pay up to 50 percent of construction costs on portions of the highway built between April 1, 1928 and December 9, 1949.

[27]For a more complete listing of Transportation-Communication grants-in-aid see Carter (1971), pp. 42-44.

[28]The National Finances 1966-67, (1966), pp. 163-164.

[29] _The National Finances 1966-67_, (1966), p. 135.

[30] _The National Finances 1974-75_, (1975), p. 238.

CHAPTER 3

APPROACHES TO THE ANALYSIS OF FEDERAL GRANTS AND PROVINCIAL FISCAL POLICY

Provincial government expenditure has been analyzed from two perspectives. This analysis has focused on the determinants of provincial government expenditures, and the impact of provincial fiscal policy on important economic variables, such as income, employment, and imports. These two analytical perspectives have not been integrated. In this chapter, selected aspects of the literature addressing each of these analytical approaches are reviewed. Specifically the fiscal response of a provincial government to federal grants,[1] and the application of I-O techniques to the analysis of provincial government fiscal policy are discussed. In Section 3.1, the recent literature on fiscal response to intergovernmental grants is reviewed. The I-O analysis of provincial fiscal policy is discussed in Section 3.2. The chapter is concluded with a brief summary of this literature.

3.1 Provincial Fiscal Response to Federal Grants

The modern theory of provincial fiscal response to federal grants is based on static consumer utility maximization theory. This analogy between the provincial government decision-maker and the individual consumer who maximizes utility was first postulated by Wilde (1968). In this model, the provincial government decision-maker is assumed to maximize an objective function

$$(3.1) \qquad U = f(E_1, E_2)$$

which is defined over a set of preferences for both public, E_1, and private, E_2, goods and services. These preferences satisfy the axioms of consumer theory.[2] The conceptualization of a budget constraint which limits the provincial decision-maker's consumption of goods and services is equally straightforward. Total expenditure on public and private goods must not exceed the sum of the personal income of provincial residents less taxes paid to other governments, plus provincial government grant and own tax revenue. Specifically, this budget constraint is

$$E_1 + E_2 = (Y - T_o) + G + T_p \ , \tag{3.2}$$

where T_p is the total tax revenue collected by the provincial government;

G is the federal grant to the provincial government;

Y is the sum of the incomes of individual citizens in the province; and

T_o is the sum of taxes paid by citizens in the province to all governments.

Provincial expenditure functions are obtained by maximizing equation (3.1) subject to equation (3.2) and solving the first-order conditions for E_1 and E_2. These expenditure functions provide a theoretical framework for analyzing provincial fiscal response to changes in federal grants.[3]

The effects of provincial borrowing have been considered in recent derivations of provincial expenditure functions. The value of provincial borrowing is assumed to detract from the utility of provincial expenditures. The provincial budget contraint is reformulated as

$$E_1 + E_2 = (Y - T_o) + G + T_p + B \ , \tag{3.3}$$

where B is the value of provincial borrowing. Clearly, this approach lends credibility to the utility maximization models of provincial government expenditure.

Ceteris paribus, the provincial fiscal response to a specific federal grant is determined theoretically by increasing the value of the grant. An increase in any grant alters the budget constraint, i.e., it increases the value of the grant variable in equations (3.2) or (3.3). Thus, the feasible choice set available to the provincial decision-maker is increased. For example, the provincial decision-maker's disposable revenue is increased by larger unconditional grants. Matching grants operate by lowering the relative price of the supported programs.

In the theoretical literature, four types of grants are analyzed: unconditional grants; conditional non-matching grants; open-ended matching grants; and closed-ended matching grants. The magnitude of the fiscal response by a provincial government to federal grants depends on both income and price elasticities, and the size of the grant relative to provincial expenditure in the absence of the grant. However, the relative degree to which each type of grant stimulates provincial government expenditure can be determined from the expenditure equations derived from equations (3.1) and (3.3). If all grants are increased equally, matching grants stimulate expenditure more than conditional non-matching and unconditional grants. In the extreme case, the stimulus of a closed-ended grant equals the stimulating effects of the conditional non-matching and unconditional grants.[4] Conditional non-matching grants stimulate increases in expenditure on the supported program which are at least as large as the increased expenditure induced by an unconditional grant. If both goods are normal, only a matching grant can induce expenditure on the supported program which is greater than the increase in the grant.[5] The specific performance of each grant can be calculated only if the form of the utility function, equation (3.1) is specified. These descriptions of the relative fiscal response to different types of grants summarize the current state of the theoretical literature. The analogy to consumer maximization theory provides a formal theoretical framework for analyzing the provincial fiscal response to federal grants.

In the empirical literature, no consensus on the expenditure response to grants has been found. In an early study employing time series data, 1954-1964, Gramlich (1969) argued that United States state and local governments "substitute" grant revenue for own tax or debt revenue.[6,7] Specifically, increased grants are matched by increased state and local government expenditure. However, this increase in expenditure is less than the amount of the grant, i.e. $0 < \partial E_1/\partial G < 1$. These substitution effects have been reported in several studies (Inman, 1971; Feldstein, 1975). In contrast, several authors have reported a "stimulation" effect for intergovernmental grants. For example, employing 1957 cross-section data for 3,080 local governments in the United States, Henderson (1968) finds that local governments increase expenditure by an amount greater than the increased grant. This result, $\partial E/\partial G > 1$, implies that the increased grant stimulates local governments to increase taxes or borrowing. A similar stimulation effect is reported by Horowitz (1968). These contradictory empirical findings concerning the nature of fiscal response to intergovernmental grants are due to the application of different functional forms of the expenditure model, the use of a variety of statistical techniques, and the diverse nature of the data.[8] In addition, differences in governments analyzed, variations in the time periods analyzed, and broadly defined government expenditure may account for these diverse empirical findings. Recently, studies of fiscal response have focused on alternative functional forms of the provincial government utility function, the effects of grants on the provincial government budget constraint, and the definition of provincial government expenditure. Differences in fiscal response attributable to differences in the form of the utility function have been investigated by Auld (1976) and Slack (1978). Auld compares the performance of a linear expenditure function derived from a quadratic utility function with a log linear expenditure function. Alternatively, Slack employs a Stone-Geary utility function and a translog indirect utility function. The conclusion of these studies indicates that the choice of functional form is important in predicting fiscal response to intergovernmental grants.

Second, consider the effects of federal grants on the budget constraint of a provincial government. McGuire (1978) argues that the effective budget constraint facing a provincial government is determined by the extent to which the provincial government can circumvent the nominal administrative conditions governing the use of grant funds. Thus, the effective budget constraint or the extent to which conditional grants can be transformed into fungible resources by a provincial government is stochastic. In empirical analysis using data on state grants to local governments in the United States, McGuire (1978) finds evidence that the effective budget constraint is markedly different from the nominal budget constraint.

Finally, consider the definition of government expenditure. In recent studies, expenditures are differentiated by program, e.g., health programs, education programs, etc., and by government. The fiscal response of each government on each program is investigated. Hardy (1976) estimates such a disaggregated model of government expenditure for Ontario and New Brunswick. Each provincial decision-maker is assumed to have a consistent set of preferences defined over seven provincial programs,[9] provincial borrowing, and private goods and services. The results of this study indicate that matching and non-matching federal grants induce a unique provincial expenditure on each program. Furthermore, Hardy (1976) demonstrates that matching grants induce a greater fiscal response than non-matching grants. In addition, each provincial decision-maker is shown to have a different fiscal response to federal grants. These results show that disaggregate analysis of provincial fiscal response is more informative than studies of aggregate expenditure responses.

The analysis of federal grants does not extend beyond their impact on expenditure by the recipient government. For example, there is no analysis of the impact which these grants have on important economic variables, for example, personal income, or the regional incidence of benefits accruing from these grants.[10]

3.2 The Input-Output Analysis of Provincial Fiscal Policy

An extensive literature applying I-O to the analysis of the impact of provincial fiscal policy has developed.[11] The capacity of I-O analysis to disaggregate the output, income, and employment multipliers by industry has encouraged the application of I-0 models to the analysis of provincial fiscal policy. Early studies in this area include Bahl and Shellhammer (1969) and Tiebout (1969). The I-0 studies of provincial fiscal policy employ conventional I-0 techniques within a regional model. The provincial economy is represented as a system of equations which express the equality of total supply and total demand for output in each industry. Total demand is composed of the demand for intermediate inputs, which summarize the inter-industry dependence of the production sector, and final demands, for example, personal consumption, investment and inventory changes, exports, and government expenditure. Assuming an increase in provincial government final demand, the system is solved for the induced increase in output in each industry. This output effect of provincial government expenditure is a short-run phenomenon in a Keynesian sense. Output is increased with no accompanying increase in exports or investment. The increase in output provides the basis for calculating the increases in employment, employment income, import requirements, and tax recovery rates of provincial government expenditure.[12] In addition, employment income multipliers are calculated for each industry, and the aggregate provincial economy. The study of provincial fiscal policy in Ontario (Kubursi, 1973, 1974, 1975, 1978 Chapter 8, and 1978 Chapter 9) illustrates the value of this approach.

3.2.1 Provincial Government Final Demand

The formulation of provincial government final demand is critical in the analysis of provincial fiscal policy. For this reason, the provincial government sector of the I-0 models is discussed in greater detail.

Provincial government expenditure is considered to involve the production of programs, e.g., health services, social welfare services, etc., using produced inputs and primary inputs such as labour. It is assumed that provincial government final demand corresponds to the production sectors of the economy. The production of government programs requires fixed proportions of inputs per dollar of expenditure. These inputs summarize the final demand that a provincial government makes on each industry.

Two specifications of provincial government final demand are employed in the analysis of provincial fiscal policy. The most common formulation is to treat provincial government expenditure as a composite commodity. Studies employing this approach include Kubursi (1973), Tiebout (1969), and Levitt (1975). Specifically, provincial expenditure is a composite commodity in the sense that the relative share of total provincial government expenditure allocated to each program is assumed to be constant. In addition these constant relative expenditure shares are preserved as total provincial government expenditure is increased. These constant shares imply that a single fixed set of inputs is required to produce each dollar of provincial government expenditure. Furthermore, these inputs are constant for all changes in provincial government expenditure. Thus, total provincial government expenditure is summarized in one final demand vector. The popularity of this conceptualization of provincial government final demand is partially explained by its minimal data requirements. Total provincial government purchases from each industry is the only data required to construct this final demand vector.

matrix rather than a vector. Each column of the matrix represents the set of inputs required to produce one dollar of a specific program. A similar matrix format is used for departments. Each column in the matrix summarizes the inputs required in the production of a single department's services. This specification of provincial final demand avoids the assumptions of composite commodities. Thus, fixed program expenditure ratios need not be assumed. The impact of a shift in provincial government expenditure from one program to another with no change in total expenditure can be analyzed within this framework. The extensive data requirements (Kubursi, 1978 Chapter 4) of this approach have limited its application to the analysis of provincial fiscal policy.

In summary, the provincial government final demand sector of regional I-0 models are specified according to total or individual program expenditures. The impact of provincial fiscal policy is more accurately analyzed when provincial government final demand is disaggregated by program or department.

Most I-0 models of provincial fiscal policy are regional models. The use of regional I-0 models to analyze the impact of provincial fiscal policy limits the scope of the analysis to the region which initiates the increase in expenditure. In the next section, interregional I-0 models of fiscal policy are reviewed.

3.2.2 Interregional I-0 Models of Provincial Fiscal Policy

Provincial economies are characteristically highly open. The openness of these economies has implications for the ability of provincial government expenditure to raise the level of provincial income.

First, some portion of provincial government expenditure and induced income accruing to household and firms "leaks out" of the domestic provincial economy into a foreign province. These import leakages have the effect of reducing the income expansion in the domestic province. Second, the increase in imports may have a "feedback" effect which further increases domestic incomes. This "feedback" results from the domestic province increasing its exports as foreign incomes rise. Of course, the increase in foreign income is induced by exports to the domestic province. The net effect of this interregional dependence is to reduce domestic income below the level which would have been induced in a closed economy.

The open nature of provincial economies indicates that regional I-O models are inappropriate for the analysis of provincial fiscal policy. The exclusion of exports included in the "feedback" effect results in an understatement of income effects and multipliers. In addition, the exclusion of other provincial economies, which are linked to the domestic region, prohibits the analysis of the interregional income effects of provincial fiscal policy. These inadequacies of regional I-O models have spurred the development of interregional I-O models of provincial fiscal policy.

The theoretical framework of the interregional I-O model of regional fiscal policy is presented by Slome (1969). The foundation of the interregional I-O model is a regional I-O model for each region and a set of interregional trade coefficients. The regional I-O models are identical to the model described in the preceding subsection. The trade coefficients are a set of constants which describe the interregional flow of commodities. These two elements provide a detailed description of the regional and industrial origin of commodities demanded for intermediate and final uses. Thus, the system of equations describing the regions becomes increasingly complex. From this cursory description of the interregional I-O model, it is obvious that the data requirements are great. For this reason, the model has not been applied extensively to the analysis of provincial fiscal policy.

Boadway and Treddenick (1978) investigated the interregional impact of selected tax increases in Ontario and the rest of Canada for the base year 1966. Two regions are included in the interregional I-O model, Ontario and the rest of Canada. The analysis is of the short-run Keynesian-type, exports to regions not included in the model and investment are assumed to be constant. In addition, federal and provincial government final demand, assumed implicitly to be a composite commodity, remains unchanged.

Boadway and Treddenick (1978) assumed a 20 percent increase in seven taxes: the Ontario and federal personal income tax, the Ontario and federal corporate income tax, the Ontario retail sales tax, the Ontario gasoline tax, and select federal commodity taxes. Alternate assumptions regarding the extent to which these taxes are shifted to other sectors of the economy are considered. Applying conventional I-O techniques to these tax changes, the employment multipliers in each industry in Ontario and the rest of Canada are derived. This study found that increases in Ontario taxes reduce employment, in the short run in the rest of Canada. However, the employment multipliers are small. Ontario industries bear most of the burden of the Ontario taxes. This tax burden is distributed unevenly across industries and varies widely for different taxes.

It is significant that a strong interregional impact of provincial fiscal policy has been found in empirical studies (Boadway and Treddenick, 1978). To date, research has been confined to the analysis of changes in specific taxes and selected federal expenditures. For example, changes in the regional incidence of federal expenditure on roads, dams, and transfer payments to persons is analyzed by Miller (1977), and defence expenditure by Leontief, et al. (1965). All of these studies suffer from poor and insufficient data rather than an undeveloped theoretical structure.

3.3 Conclusion

In this chapter, the literature relevant to two aspects of provincial government expenditure has been reviewed. These are, first, the impact of federal grants on provincial government expenditure, and second, the I-O analysis of provincial fiscal policy. In both areas, the theoretical analysis is complete. However, empirical research in these areas is incomplete due to severe data limitations.

In the next chapter, a behavioral model of regional government expenditure is developed. This model explicitly recognizes the differential fiscal response induced by different types of federal grants.

Footnotes to Chapter 3

[1]Many important papers in the area of fiscal response to intergovernment grants include the analysis of federal-state, provincial-local, and federal-local granting relationship. For completeness, this discussion reviews several of these papers.

[2]The seven axioms are: completeness, transitivity, rational choice, non-saturation, continuity of preferences, strict convexity, and smooth indifference curves. For a discussion of these axioms, see Green (1971).

[3]Wilde's (1968) formulation of the maximization problem implies that the provincial decision-maker can allocate total private plus provincial government income <u>directly</u> to private and public spending. In fact, the allocation is made <u>indirectly</u> through provincial taxes, T_p. This allocation problem is formulated correctly by defining E_1 and E_2 in terms of taxes, income, and federal grants,

$$E_1 = G + T_p ,$$

and $$E_2 = Y - T_o .$$

Here, T_o is total taxes: the sum of municipal taxes, T_m, provincial taxes, T_p, and federal taxes, T_f.

In choosing T_p, a provincial government effects both E_1 and E_2. Thus, the constrained maximization problem is to choose T_p such that the provincial decision-maker's utility function

$$U = U(G + T_p, Y - T_o)$$

is maximized subject to the budget constraint for federal and municipal governments, and a constraint specifying the nature of the federal grant, G.

The issues involved in the indirect model of provincial expenditure allocation are relevant to the empirical studies in which E_2 is represented as $Y - T_o$. For example, see Hardy (1976) and Slack (1978).

[4]This extreme case occurs when

(1) the closed-ended grant ceiling is an effective constraint on the provincial government expenditure decisions, and

(2) the conditional non-matching grant does not completely finance the supported program.

In this case, the closed-ended grant and the conditional non-matching grant produce only an income effect. For a complete discussion of this point, see Wilde (1968).

[5]This expenditure effect of matching grants arises when the provincial governments demand for the supported program is price elastic.

[6]The utility function formulated by Gramlich is for citizens of the state, not an individual decision-maker. Thus, it represents a community utility function.

[7]Specifically, the decision-maker is assumed to suffer increasing marginal disutility as borrowing increases relative to current construction expenditure.

[8]Auld (1976) investigates the effect which differences in functional form and data have on the fiscal response coefficients of local governments in Ontario.

[9]The programs analyzed by Hardy are health services, social welfare programs, education, road transportation, settlement and agriculture programs, fish and game, and forests.

[10]Several economists have analyzed the impact of federal grants on important economic variables other than provincial government expenditure. For example, Bahl and Warford (1972) analyze the interstate variation in the opportunity cost of making use of United States federal grants, Courchene (1979) analyzes conditional and unconditional grants net of federal taxes levied to finance the Canadian grant program, and Swan (1977) analyzes alternative distribution criteria for federal grants in Canada.

[11]In addition, the provincial impact of federal government expenditure has been analyzed by Kubursi (1973) and Miller (1974). The regional (state) impact of United States federal government defence expenditures are analyzed by Leontief (1965).

[12]Provincial government taxes per dollar of expenditure are included in provincial government primary inputs.

[13]Exceptions to this comparison of I-O and macroeconomic models are available. For example, see the macroeconomic model of the Nova Scotia economy, Czamanski (1972).

CHAPTER 4

A BEHAVIORAL MODEL OF REGIONAL GOVERNMENT EXPENDITURE

In this chapter, a behavioral model of regional government expenditure is developed. This model describes the mechanisms whereby changes in federal grants to regional governments affect the allocation of regional government expenditure on f expenditure programs. Each regional government decision-maker is assumed to maximize his utility which is a function of f regional government programs subject to the regional government's budget constraint. Employing this model, a regional government's response to four types of federal grants are analyzed. The four types of federal grants[1] analyzed are:

1. unconditional grants,
2. conditional non-matching grants,
3. open-ended matching grants, and
4. closed-ended matching grants.

The comparative static effects of each of these grants on the allocation of regional government expenditure is dealt with separately in Sections 4.2 through 4.5 respectively. The general optimization problem for the regional government is discussed in Section 4.1. The chapter is concluded with Section 4.6 where a summary of the comparative static results is presented.

4.1 The General Optimization Model

Regional government decision-makers are assumed to have a utility function defined over f regional government programs. This utility function is not considered to be a community indifference curve or part of a social welfare function. For this reason, it may not reflect accurately the preferences of regional residents at any given time.[2]

Specifically, the kth regional government decision-maker's objective function is a Stone-Geary utility function,[3,4]

$$(4.1) \qquad U^k = \sum_{K=1}^{f} b_K^k \log (g_K^k - \beta_K^k),$$

where g_K^k is the level of program K consumed by regional government k, β_K^k is the minimum acceptable consumption level of program K in region k, and b_K^k is the marginal budget share of program K out of supernumerary income in region k. The parameters of this utility function are constrained such that the conditions

$$b_K^k \geq 0,$$

$$(4.2) \qquad \sum_{K=1}^{f} b_K^k = 1,$$

and

$$(g_K^k - \beta_K^k) > 0$$

are satisfied.

Each regional government decision-maker maximizes his utility, equation (4.1), subject to a regional government budget constraint. The form of the budget constraint and, thus, the expenditure function derived in the optimization process, depends on the type of federal grant received by the regional government. In this analysis, regional government non-grant revenue is considered to be determined exogenously.[5] In the following sections, the constrained maximization problem, the expenditure function for regional government programs, and a comparative static analysis of changes in each type of federal grant is presented.

4.2 Unconditional Grants to Regional Governments

Federal unconditional grants to a regional government increase the total revenue available to the government. These grants are a lump sum payment to the regional government with no restriction on the type of program which may be supported from this grant. In this granting arrangement, the kth decision-maker's constrained optimization problem is: maximize (4.1) subject to regional government k's budget constraint,

$$(4.3) \qquad \Gamma^k + \bar{\Gamma}^k = \sum_{K=1}^{f} P_K^k \, g_K^k,$$

where Γ^k represents regional government k's non-grant revenue, $\bar{\Gamma}^k$ represents the unconditional grant to regional government k, and P_K^k represents the price of the Kth regional government program in region k. Solving the f+1 first order conditions of this constrained maximization problem, values of provincial government expenditure on all programs, K=1,...,f, are obtained. These expenditure functions take the form of

$$(4.4) \qquad P_K^k \, g_K^k = P_K^k \, \beta_K^k + b_K^k \, [\Gamma^k + \bar{\Gamma}^k - \sum_{L=1}^{f} P_L^k \, \beta_L^k].$$

This set of expenditure functions is referred to as the Linear Expenditure System.

Regional government k's change in expenditure on service K induced by a one dollar increase in the unconditional grant, $\bar{\Gamma}^k$, is

$$(4.5) \qquad \eta_K^k = \frac{\partial(P_K^k \, g_K^k)}{\partial\bar{\Gamma}^k}\bigg|_{dP_{K=0}^k} = b_K^k \, .$$

This coefficient, η_K^k, indicates the marginal allocation of supernumerary income, $(\Gamma^k + \bar{\Gamma}^k - \sum_{L=1}^{f} P_L^k \, \beta_L^k)$, by regional government k to expenditure on program I. In general,

$$\eta_K^k = b_K^k$$

is not equal to the average propensity to consume. The marginal and average propensities to consume program K are equal only for consumption out of supernumerary income. In addition, the marginal budget share, b_K^k, is constant. Thus, for provincial government k's expenditure out of supernumerary income, the Linear Expenditure System is consistent with the I-O model developed in Chapter 5.

Considering two programs, K and I, the impact of an unconditional grant on region k's consumption of programs K and I can be represented diagrammatically. In Figure 4.1, the pre-grant budget constraint,

$$(4.6) \qquad \Gamma^k = \sum_{K}^{I} P_K^k \, g_K^k \, ,$$

is given by line aa. Receipt of an unconditional grant, $\bar{\Gamma}^k$, increases regional government k's budget and shifts the budget constraint out to the right. The post-unconditional grant budget constraint, equation (4.3), is given by line bb. The impact of the unconditional grant, $\bar{\Gamma}^k$, is to induce government k to increase consumption of program K from g_{K1}^k to g_{K2}^k. This increase in k's consumption of program K is equal to the constant fraction b_K^k of the grant. That is,

FIGURE 4.1

THE BUDGET CONSTRAINT AND "UNCONDITIONAL GRANT EXPANSION PATH" FOR AN UNCONDITIONAL GRANT $\bar{\Gamma}^k$

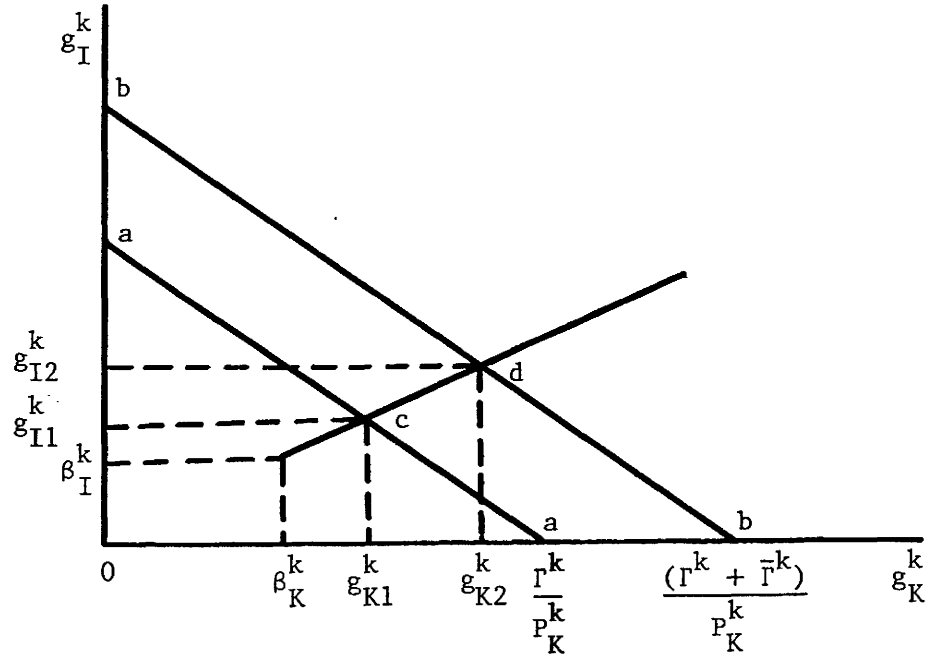
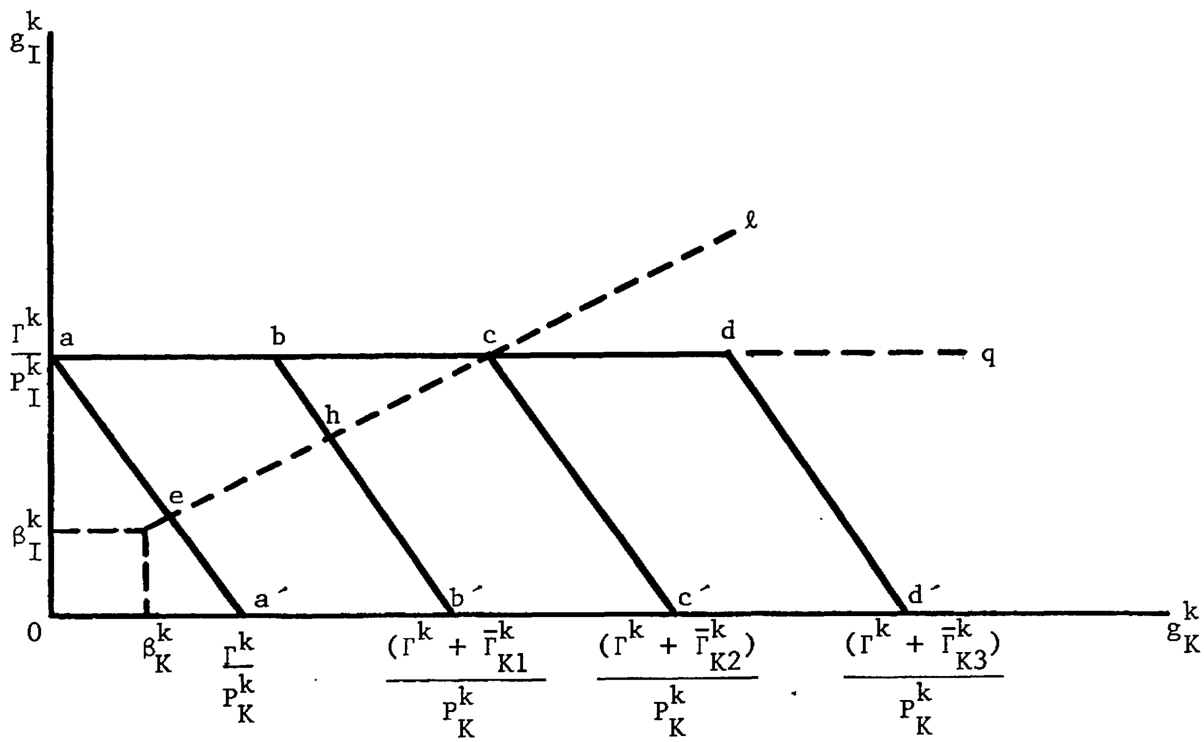


FIGURE 4.2

THE BUDGET CONSTRAINT AND "CONDITIONAL NON-MATCHING GRANT EXPANSION PATH" FOR A CONDITIONAL NON-MATCHING GRANT, $\bar{\Gamma}_K^k$



$$(4.7a) \qquad g_{K2}^{k} - g_{K1}^{k} = b_{K}^{k} \frac{\bar{\Gamma}^{k}}{P_{K}^{k}} ,$$

where

$$(4.7b) \qquad \sum_{L=K}^{I} b_{L}^{k} = 1.$$

Similarly, government k's consumption of program I increases by the constant fraction b_{I}^{k} of the grant.

$$(4.7c) \qquad g_{I2}^{k} - g_{I1}^{k} = b_{I}^{k} \frac{\bar{\Gamma}^{k}}{P_{I}^{k}}$$

In the f dimensional case, equation (4.7c) can be expressed as the increase in regional government k's expenditure on program I when unconditional grants increase by one dollar. Equation (4.7c) is, thus, written as

$$(4.8) \qquad \eta_{I}^{k} = \left.\frac{\partial(P_{I}^{k}\ g_{I}^{k})}{\partial\bar{\Gamma}^{k}}\right|_{dP_{I}^{k} = 0} = b_{I}^{k} .$$

In some situations, the federal government may implicitly intend to support only one program, e.g., program K, with the unconditional grant. In this event, the increase in regional government expenditure on other programs, e.g., program I, which is induced by the unconditional grant, η_{I}^{k}, is the "leakage effect" of the unconditional grant (Wilde, 1968).

The constant marginal increase in government k's consumption of programs K and I, b_{K}^{k} and b_{I}^{k}, induced by an unconditional grant is reflected in the linear "unconditional grant" expansion path cd in Figure 4.1. This expansion path is linear only for consumption levels of g_{K}^{k} and g_{I}^{k} greater than the minimum acceptable levels of programs K and I, β_{K}^{k} and β_{I}^{k} .

In summary, unconditional grants to a regional government will induce that government to demand more of each program. The increased demand for each program K, K=1,...,f, is a fixed proportion, b_K^k, of the unconditional grant. In the following section, regional governments' demand for programs induced by a conditional non-matching grant is analyzed.

4.3 Conditional Non-Matching Grants to Regional Governments

A conditional non-matching grant is a lump sum transfer to a regional government. The granting arrangements of a conditional non-matching grant require that the grant be used only to support the program specified in the grant contract. However, this restriction does not prevent the regional government from reallocating non-conditional grant revenue to non-supported programs.

This description of the conditional non-matching grant contract indicates two possible cases which may arise in analyzing regional government k's demand for programs. These two cases are:

1. the grant only partially supports the aided program, or
2. the grant exactly supports the aided program.

First, consider case 1, in which the conditional non-matching grant, $\bar{\Gamma}_K^k$, only partially supports the aided program, K. This case is represented by equation (4.9a),

$$\bar{\Gamma}_K^k < P_K^k \, g_K^k \, . \tag{4.9a}$$

In this case, the effective budget constraint facing region k's decision-maker is

$$(4.9b) \qquad \Gamma^k = P_K^k \, g_K^k - \bar{\Gamma}_K^k + \sum_{\substack{L=1 \\ \neq K}}^{f} P_L^k \, g_L^k ,$$

where $P_K^k \, g_K^k - \bar{\Gamma}_K^k$ represent regional government k's expenditure on program K in excess of the grant. Rearranging equation (4.9b), the constraint can be written in a form similar to the unconditional grant budget constraint, equation (4.3). This constraint is

$$(4.9c) \qquad \Gamma^k + \bar{\Gamma}_K^k = \sum_{L=1}^{f} P_L^k \, g_L^k .$$

Maximizing (4.1) subject to (4.9c) and solving the f+1 first order conditions for g_I^k, I=1,...,K,...,f, regional government k's expenditure functions for all programs are found. These expenditure functions are of the form

$$(4.10) \qquad P_I^k \, g_I^k = P_I^k \, \beta_I^k + b_I^k \, (\Gamma^k + \bar{\Gamma}_K^k - \sum_{L=1}^{f} P_L^k \, \beta_L^k).$$

The change in regional government k's expenditure on program K, γ_K^k, and the leakage coefficient, γ_I^k, induced by a one dollar change in the conditional non-matching grant to program K are equivalent to the respective b_K^k and b_I^k coefficients for an unconditional grant. These coefficients are presented in equation (4.5).

Second, consider case 2 in which the conditional non-matching grant for program K exactly supports the program. This case is described by equation (4.11a).

$$(4.11a) \qquad \bar{\Gamma}_K^k = P_K^k \, g_K^k$$

Equation (4.11a) implies that non-grant revenue, Γ^k, is totally spent on non-supported programs L $\neq$ K. Thus, non-supported program expenditure is represented by equation (4.11b),

$$(4.11b) \qquad \Gamma^k = \sum_{\substack{L=1 \\ \neq K}}^{f} P_L^k \, g_L^k \, .$$

A description of the basic content of a conditional non-matching grant contract facilitates an interpretation of equation (4.11b). Equation (4.11b) then indicates regional government k's maximum allowable expenditure on non-supported programs.

The regional government decision-maker's optimization problem, in case 2, involves maximizing (4.1) subject to (4.11a) and (4.11b). Solving the f+2 first order conditions from this constrained maximization for g_I^k, I=1,K,...,f, regional government k's expenditure function for each program is derived. Specifically, the expenditure function for program K, the supported program, is

$$(4.12) \qquad P_K^k \, g_K^k = \bar{\Gamma}_K^k \, .$$

Regional government k's expenditure function for program I, a non-supported program, is

$$(4.13) \qquad P_I^k \, g_I^k = P_I^k \, \beta_I^k + \frac{b_I^k}{\sum\limits_{\substack{L=1 \\ \neq K}}^{f} b_L^k} \left[\Gamma^k - \sum_{\substack{L=1 \\ \neq K}}^{f} P_L^k \, \beta_L^k\right],$$

I≠K.

The impact of a one dollar increase in $\bar{\Gamma}_K^k$ on regional government k's program expenditure can now be determined. Differentiating (4.12) and (4.13) with respect to $\bar{\Gamma}_K^k$,

$$(4.14a) \qquad \gamma_K^k = \left.\frac{\partial(P_K^k\, g_K^k)}{\partial \bar{\Gamma}_K^k}\right|_{dP_K^k = 0} = 1$$

and

$$(4.14b) \qquad \gamma_I^k = \left.\frac{\partial(P_I^k\, g_I^k)}{\partial \bar{\Gamma}_K^k}\right|_{dP_I^k = 0} = 0, \qquad I=1,\ldots,f,\ I\neq K,$$

it is seen that the total increase in the grant is spent on the supported program K. Thus, under the conditions specified in case 2, an increase in the conditional non-matching grant $\bar{\Gamma}_K^k$ will not alter regional government revenue allocation.

The difference between the impact on regional government expenditure of an increase in a conditional non-matching grant and an equal increase in income is the "deflection effect" of the conditional non-matching grant (Wilde, 1968). The impact of a one dollar increase in income is equivalent to the impact of a one dollar increase in the unconditional grant which is described in equations (4.5) and (4.8). Comparing equations (4.5) and (4.14a), and equations (4.8) and (4.14b), it is clear that there is a "deflection effect" associated with case 2 of a conditional non-matching grant.

To summarize, case 1 and case 2 of a conditional non-matching grant are reviewed diagrammatically in Figure 4.2. Consider two programs I and K, where program K is supported by a conditional non-matching grant. The pre-grant budget constraint is represented by line aa′ and regional government k consumes the bundle of programs corresponding to point e. A conditional non-matching grant equal to $\bar{\Gamma}_{K1}^k$ shifts the budget constraint aa′ to the right by $\frac{\bar{\Gamma}_{K1}^k}{P_K^k}$ units.

The conditions of the grant contract, however, prevent government k from spending any of these funds on program I. Thus, the post-grant budget constraint is the kinked curve abb′. Line segment bb′ of this budget contraint represents the constraint specified in equation (4.9c), while line segment ab represents the constraint specified in equation (4.11b). Similarly, conditional non-matching grants of $\bar{\Gamma}^k_{K2}$ and $\bar{\Gamma}^k_{K3}$ shift the pre-grant budget constraint to constraints acc′ and add′ respectively.

Considering specific grants, regional government k's expenditure pattern is illustrated. In Figure 4.2, line eℓ is the linear expansion path representative of the Linear Expenditure System. Thus, conditional non-matching grants of $\bar{\Gamma}^k_{K1}$ and $\bar{\Gamma}^k_{K2}$ induce government k to consume combinations of g^k_I and g^k_K represented by points h and c respectively. Here, a marginal increase in the grant which is less than $\bar{\Gamma}^k_{K2}$ induces an increase in expenditure on programs I and K. This increase in expenditure is a constant fraction b^k_I and b^k_K, of the grant. b^k_I also represents the "leakage effect" of the conditional non-matching grant $\bar{\Gamma}^k_{K1}$.

It is obvious that at point h

$$(4.15a) \qquad g^k_K > \frac{\bar{\Gamma}^k_{K1}}{P^k_K}$$

and, thus, the grant $\bar{\Gamma}^k_{K1}$ only partially supports the aided program. This expenditure situation is obviously included in case 1 where bb′ is the binding constraint. Case 1 also describes all grants less than $\bar{\Gamma}^k_{K2}$.

For a grant greater than or equal to $\bar{\Gamma}^k_{K2}$, i.e., $\bar{\Gamma}^k_{K3}$, the aided program, K, is completely supported by the grant. That is,

$$(4.15b) \qquad g_K^k = \frac{\bar{\Gamma}_{K2}^k}{p_K^k}$$

where the grant equals $\bar{\Gamma}_{K2}^k$, and similarly

$$(4.15c) \qquad g_K^k = \frac{\bar{\Gamma}_{K3}^k}{p_K^k}$$

for a grant equal to $\bar{\Gamma}_{K3}^k$. Here, equations (4.11a) and (4.11b), which are represented by line ab, are the effective constraints. This expenditure situation corresponds to case 2 in which an increase in the grant does not alter regional government expenditure patterns. That is, $\gamma_K^k = 1$ and $\gamma_I^k = 0$.

In general, the "conditional non-matching grant expansion path" is the kinked line, ecq, in Figure 4.2. The corner, at point c, represents the minimum grant which exactly supports the aided program. All grants greater than this minimum represent the range over which the "deflection effect" operates.

In contrast, the "unconditional grant" expansion path, in Figure 4.1, coincides with the income expansion path. This expansion path is represented in Figure 4.2 as line eℓ and does not exhibit a "deflection effect".

In conclusion, it has been demonstrated in this section that regional expenditure response to a system of conditional non-matching grants depends upon whether the grant wholly or partially supports the aided program. In either case, however, the sum of the grant coefficients is unity,

$$(4.16) \qquad \sum_{I=1}^{f} \gamma_I^k = 1.$$

4.4 Conditional Open-Ended Matching Grants to Regional Governments

Changes in regional government expenditure motivated by the unconditional and conditional non-matching grants described in Sections 4.2 and 4.3 represent a shift in a regional government's Marshallian demand curve for a program K, K=1,...,f. In contrast, federal open-ended and closed-ended matching grants to regional governments operate through the price system and represent a movement along the region's Marshallian demand curve for programs. In this section, the impact of conditional open-ended matching grants on regional government expenditure is analyzed.

Open-ended matching grants are transfer payments from the federal government to a regional government. The value of one of these grants is solely determined by two components:

1. the matching ratio, ω_K^k, and
2. the regional government's expenditure on the aided program, $P_K^k\ g_K^k$.

This grant is conditional in the sense that the grant funds are tied to expenditure on a specific regional government program. It is open-ended in the sense that grant funds are available to the regional government for support of the aided program regardless of the level of expenditure.

Open-ended matching grants affect regional government expenditure decisions by altering the budget constraint confronting the regional decision-maker. In the most elementary form, this grant $\bar{\Gamma}_{K0}^k$, can be considered to increase regional government k's revenue, (4.17a) $$\Gamma^k + \bar{\Gamma}^k_{K0} = \sum_{L=1}^{f} P^k_L \, g^k_L \, .$$

The value of the open-ended matching grant for program K, $\bar{\Gamma}^k_{K0}$, is equal to a constant per-dollar share of total regional expenditure on K. Thus, the open-ended matching grant to government k for program K is

(4.17b) $$\bar{\Gamma}^k_{K0} = \omega^k_K (P^k_K \, g^k_K) \, .$$

The constant per-dollar share of total regional government expenditure, ω^k_K, is referred to as the matching ratio.[6] This matching ratio is defined as

(4.17c) $$\omega^k_K = \frac{\bar{\Gamma}^k_{K0}}{P^k_K g^k_K} \, .$$

Substituting for $\bar{\Gamma}^k_{K0}$ in equation (4.17a), a more interpretable form of the budget constraint is obtained. If all programs I, I=1,...,K,...f, are supported by an open-ended matching grant, the appropriate budget constraint for region k is

(4.17d) $$\Gamma^k = \sum_{I=1}^{f} (1-\omega^k_I) P^k_I \, g^k_I \, ,$$

where

(4.17e) $$0 < \omega^k_I < 1.$$

Thus, it is seen that open-ended matching grants lower the effective price of a supported program to the regional government. It is also obvious that a change in the matching ratio, ω^k_K, changes the effective price, P^{*k}_K, of the supported program,

(4.17f) $$dP^{*k}_K = -P^k_K \, d\omega^k_K \, .$$

The constrained maximization problem in a federal system of open-ended matching grants, involves maximizing (4.1) subject to (4.17d). Solving the f+1 first order conditions for g_I^k, I=1,...,K,...,f, regional government k's expenditure functions are obtained,

$$P_I^k\, g_I^k = P_I^k\, \beta_I^k + \frac{b_I^k}{(1-\omega_I^k)}\, [\Gamma^k - \sum_{L=1}^{f} (1-\omega_L^k) P_L^k\, \beta_L^k] \ . \tag{4.18}$$

The increase in the open-ended matching grant for program K in region k which is transmitted through an increase in the matching ratio ω_K^k on government k's expenditure on program K and I is

$$\gamma_{KK}^{k'} = \left.\frac{\partial(P_K^k\, g_K^k)}{\partial\omega_K^k}\right|_{dP_K^k = 0} = \frac{b_K^k}{(1-\omega_K^k)^2}[\Gamma^k - \sum_{L=1}^{f} (1-\omega_L^k) P_L^k \beta_L^k] + \frac{\beta_K^k\, P_K^k\, b_K^k}{(1-\omega_K^k)} \ , \tag{4.19a}$$

and

$$\gamma_{KI}^{k'} = \left.\frac{\partial(P_I^k\, g_I^k)}{\partial\omega_K^k}\right|_{dP_I^k = 0} = \frac{b_I^k\, P_K^k\, \beta_K^k}{(1-\omega_I^k)} \ . \tag{4.19b}$$

Here, both K and I are programs supported by an open-ended matching grant. If program I is not supported, $\omega_I^k = 0$, the cross substitution effect of an increase in the matching ratio ω_K^k is

$$\gamma_{KI}^{k'} = b_I^k\, P_K^k\, \beta_K^k \ . \tag{4.19c}$$

This increase in expenditure on service I, resulting from an increase in the grant for service K which is described by equations (4.19b) and (4.19c), is the "leakage effect" of an open-ended matching grant.

Consider this case in greater detail. The regional government's pre-grant budget constraint is summarized by line aa′ in Figure 4.3. Here, the matching ratios for both programs K and I are zero, $\omega_K^k = \omega_I^k = 0$, and k consumes the combination of programs corresponding to point c on aa′. When the regional government receives an open-ended matching grant to assist it in financing expenditures on program K, the unit price of program K is reduced by ω_K^k, the matching ratio. Thus, for government k, the effective price of program K is $(1-\omega_K^k)P_K^k$. This reduction in the price of K is reflected in the post-grant budget constraint ab. At this reduced price, government k consumes g_K^k and g_I^k in the combination indicated by point d on ab. By continuously varying ω_K^k, the "open-ended matching grant expansion path," cde, is traced out. This expansion path is flatter than the "unconditional grant expansion path," cf . The relative flatness of cde reflects the substitution effect of an open-ended matching grant. Thus, the "leakage effect" of an open-ended matching grant is less than that of an equivalent unconditional grant.

This concludes the analysis of open-ended matching grants. In the next section, closed-ended matching grants are discussed.

4.5 Conditional Closed-Ended Matching Grants to Regional Governments

A closed-ended matching grant is a transfer payment from the federal government to a regional government. This grant is conditional in that grant funds are specifically tied to expenditure on the supported program. However, this condition does not prevent regional

FIGURE 4.3

THE BUDGET CONSTRAINT AND "OPEN-ENDED MATCHING GRANT EXPANSION PATH" FOR AN OPEN-ENDED MATCHING GRANT, $w_K^k P_K^k g_K^k$

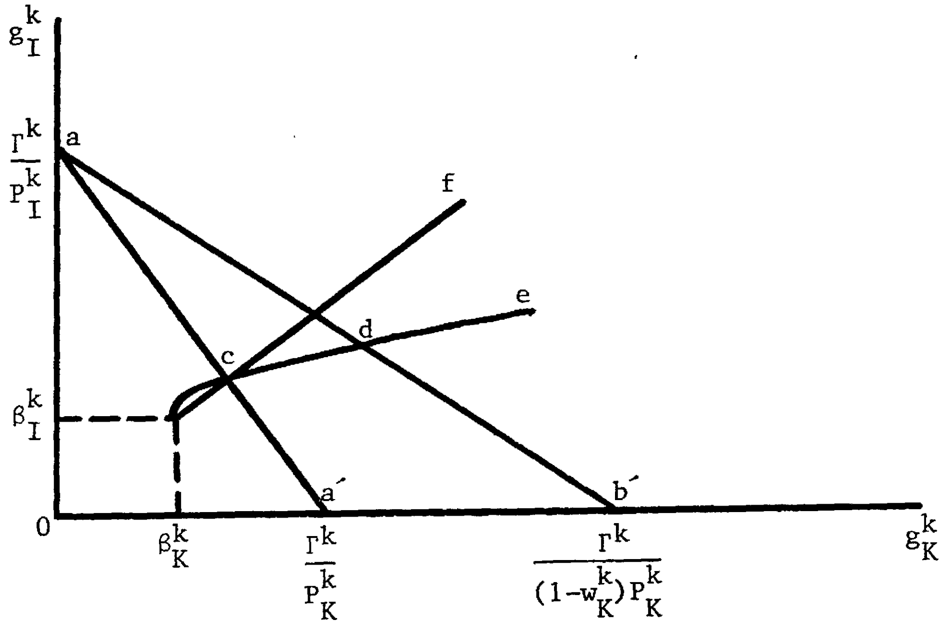
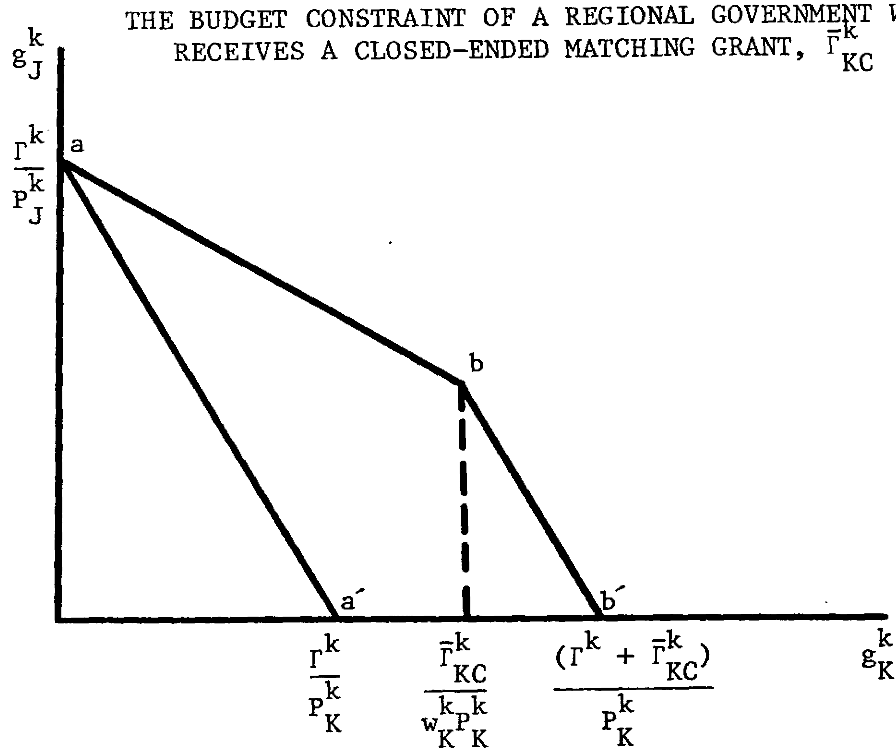


FIGURE 4.4

THE BUDGET CONSTRAINT OF A REGIONAL GOVERNMENT WHICH RECEIVES A CLOSED-ENDED MATCHING GRANT, $\bar{\Gamma}_{KC}^k$



governments from reallocating other revenue to non-supported programs.

The matching property of the grant enters through the per-dollar subsidy paid by the federal government for expenditure on the supported program. This per-dollar subsidy, the matching ratio ω_K^k, lowers the effective price of the program to the regional government.

The grant is closed-ended in that the federal government will only provide matching funds up to some pre-determined value. The maximum value of the grant, therefore, limits the range over which the regional government faces a lower effective price of the supported program. This is in contrast to the open-ended matching grant which lowers the effective price of the supported program over the entire range of consumption.

The value of a closed-ended matching grant is determined by the lesser of:

1. the product of the matching ratio and the value of regional government expenditure on the supported program, $\omega_K^k(P_K^k\ g_K^k)$, or
2. a maximum value specified by the federal government, $\bar{\Gamma}_{KC}^k$.

This description of a closed-ended matching grant indicates that three situations may arise:

1. regional government expenditure on the supported program is less than the weighted maximum value of the grant, $\bar{\Gamma}_{KC}^k/\omega_K^k$,
2. regional government expenditure on the supported program exactly equals the weighted maximum value of the grant, and

3. regional government expenditure on the supported program exceeds the weighted maximum value of the grant.

Each case must be considered in analyzing a regional government's expenditure response to a closed-ended matching grant.

Discussion of these three cases is facilitated by visualizing the regional government's budget constraint in two dimensions. This constraint is presented in Figure 4.4. The pre-grant budget constraint is summarized by line aa′. When regional government k receives a closed-ended matching grant to support program K, the constraint shifts and rotates to the right. This new constraint is the kinked line abb′. Here, line segment ab represents the range over which the price of program K is reduced. This corresponds to the events described in case 1. At point b, the grant limit, $\bar{\Gamma}^k_{KC}$, has been reached. This point represents the event described in case 2. Case 3 is summarized by line segment bb′. Here, the price of program K is not reduced, but government k's total revenue includes the matching funds from previous program units consumed. In this case, matching funds are equivalent to a lump sum transfer.

A general form of the regional government's budget constraint useful for analyzing this type of grant is

$$(4.20) \qquad \Gamma^k + \min\,[\omega^k_K\, P^k_K\, g^k_K,\ \bar{\Gamma}^k_{KC}] = \sum_{L=1}^{f} P^k_L\, g^k_L\ .$$

Here, total regional government revenue is composed of non-grant revenue, Γ^k, and closed-ended matching grant revenue, $\omega^k_K\, P^k_K\, g^k_K$. The maximum value of the grant is $\bar{\Gamma}^k_{KC}$, the grant limit. A budget constraint specific to each case is obtained from equation (4.20) by choosing a value of regional government expenditure on the supported program. The value of this expenditure determines whether $\omega_K^k \, P_K^k \, g_K^k$ is less than, equal to, or greater than the grant limit, $\bar{\Gamma}_{KC}^k$. Thus, the value of the second term on the left-hand side of equation (4.20), the grant term, and the exact form of the budget constraint for each case are determined.

Each case will now be considered. In analyzing each case, two comparative static effects must be presented. These are:

1. the impact of a change in the matching ratio, ω_K^k, on government expenditure, and
2. the impact of a change in the grant limit, $\bar{\Gamma}_{KC}^k$, on government expenditure.

Each parameter, ω_K^k and $\bar{\Gamma}_{KC}^k$, can affect a regional government's demand for programs.[7] These comparative static effects are presented with the aid of diagrams after the expenditure functions for all three cases are discussed.

Consider the expenditure function for a regional government which has an expenditure pattern on the supported program which is described by case 1. In case 1, regional government expenditure on the supported program, K, is less than the weighted grant limit, $\bar{\Gamma}_{KC}^k/\omega_K^k$. In this case, the regional government is consuming on line segment ab in Figure 4.4. Here, the closed-ended matching grant, $\omega_K^k \, P_K^k \, g_K^k$, is less than the grant limit, $\bar{\Gamma}_{KC}^k$. This is mathematically represented as

$$\omega_K^k \, P_K^k \, g_K^k < \bar{\Gamma}_{KC}^k \ . \tag{4.21}$$

As the grant is less than the grant limit, the grant term in equation

(4.20) is equal to $\omega_K^k P_K^k g_K^k$ and regional government k is purchasing program K at the subsidized price, $(1-\omega_K^k)P_K^k$. From equation (4.20), it is apparent that regional government k faces a budget constraint similar to equation (4.17d) in Section 4.4. If (4.21) holds for all programs, the budget constraint for case 1 of a closed-ended matching grant is identical to equation (4.17d).

In this case, the regional government decision-maker's optimization problem is formulated as maximizing his utility function, equation (4.1), subject to the case 1 closed-ended matching grant budget constraint, equation (4.17d). Here, it is assumed that $\omega_I^k = 0$ for all $I \neq K$. Solving the f+1 first order conditions from this constrained maximization process for g_I^k, I=1,...,k,...f, government k's expenditure functions are obtained. These expenditure functions are equivalent to the expenditure functions for programs supported by an open-ended matching grant. These functions are described in equation (4.18) in Section 4.4.

Second, consider the situation when regional government k's expenditure behavior is described by case 2. Here, regional government k's expenditure on the supported program exactly equals the weighted grant limit. In Figure 4.4, this corresponds to the regional government consuming at point b, the corner. Thus, the value of the grant is equal to the value of the grant limit and the value of expenditure on the supported program is

$$(4.22a) \qquad P_K^k \, g_K^k = \frac{\bar{\Gamma}_{KC}^k}{\omega_K^k} \, .$$

Setting the grant term in equation (4.20) equal to $\omega_K^k P_K^k g_K^k$ and substituting $\frac{\bar{\Gamma}_{KC}^k}{\omega_K^k}$ from (4.22a) for $P_K^k g_K^k$, the closed-ended matching grant budget constraint for this case is derived,

$$(4.22b) \qquad \Gamma^k - (1-\omega_K^k) \frac{\bar{\Gamma}_{KC}^k}{\omega_K^k} = \sum_{\substack{L=1 \\ \neq K}}^{f} P_L^k g_L^k .$$

The second term on the left-hand side of (4.22b), $(1-\omega_K^k) \frac{\bar{\Gamma}_{KC}^k}{\omega_K^k}$, represents the previous matching funds for program K paid to government k.

Maximizing (4.1) subject to (4.22b) and solving the f+1 first order conditions for g_I^k, government k's expenditure functions can be derived. Assuming that program K is the only supported program, $\omega_I^k = 0$, I≠K, regional government k's expenditure function for program K is described by equation (4.22a). Similarly, government k's expenditure function on program I is

$$(4.23) \qquad P_I^k g_I^k = P_I^k \beta_I^k + \frac{b_I^k}{\sum_{\substack{L=1 \\ \neq K}}^{f} b_L^k} [\Gamma^k - \frac{(1-\omega_K^k)\bar{\Gamma}_{KC}^k}{\omega_K^k} - \sum_{\substack{L=1 \\ \neq K}}^{f} P_L^k \beta_L^k].$$

Although the form is somewhat altered, this expenditure equation exhibits the fundamental properties of the Linear Expenditure System.

Finally, consider case 3 in which regional government expenditure on the supported program exceeds the weighted grant limit which is described by equation (4.24), (4.24) $P_K^k \; g_K^k > \bar{\Gamma}_{KC}^k / \omega_K^k$.

Here, regional government k purchases program K at the market price P_K^k. In this situation, the regional government receives the maximum value of the grant, $\bar{\Gamma}_{KC}^k$, and treats this grant as an unconditional transfer. The budget constraint for case 3 is represented by equation (4.20) when the grant term is equal to the grant limit $\bar{\Gamma}_{KC}^k$. This constraint is similar to the constraint imposed for a conditional non-matching grant, equation (4.9c), but, in this case, $\bar{\Gamma}_{KC}^k$ is substituted for $\bar{\Gamma}_K^k$.

Maximizing (4.1) subject to the modified version of (4.9c) and solving the f+1 first order conditions for g_I^k, I=1,...,k,...,f, regional government k's expenditure functions are derived. These expenditure functions are similar to those for case 1 of a conditional non-matching grant, equations (4.9c) and (4.10), after the appropriate substitution of $\bar{\Gamma}_{KC}^k$ is made.

The regional government expenditure functions which are derived for closed-ended matching grants illustrate that the determinants of regional government expenditure are varied. The functional form of the expenditure equations depends upon the value of regional government expenditure on the supported program relative to the weighted grant limit.

The different functional forms of the regional government expenditure equations for a closed-ended matching grant indicate that the impact of a change in the matching ratio, ω_K^k, and the grant limit, $\bar{\Gamma}_{KC}^k$, will vary depending upon which case of expenditure behavior is applicable. These comparative static effects illustrate how regional governments alter their expenditure on each program as the grant parameters are changed. These comparative static effects are now discussed with the aid of Figures 4.5 and 4.6.

First, consider the comparative static effects of a change in the matching ratio. Two programs, K, a supported program, and I, a non-supported program, are analyzed. A reduction in the matching ratio, ω_K^k, is illustrated in Figure 4.5. Given the initial matching ratio and grant limit, regional government k's budget constraint is abb´. Here, the slope of line segment ab is equal to the relative price ratio $(1-\omega_K^k)P_K^k/P_I^k$, and the grant limit, $\bar{\Gamma}_{KC}^k$, equals a´b´measured in terms of program K. Initially, it is assumed that government k consumes the combination of programs K and I represented by point d on segment bb´ of the budget constraint. This point, d, lies on the income expansion path eh which coincides with the "unconditional grant expansion path." This initial situation corresponds to case 3 which is described by equation (4-24), the budget constraint, and equation (4-10), the expenditure function.

As the matching ratio is progressively reduced with $\bar{\Gamma}_{KC}^k$ held constant, the budget constraint rotates around point a and becomes steeper. In Figure 4.5, this reduction in ω_K^k for a given $\bar{\Gamma}_{KC}^k$ is represented by constraints adb´, acb´, ab´, and aa´.[8] Given $\bar{\Gamma}_{KC}^k$ in Figure 4.5, initial reductions in ω_K^k do not influence government k's expenditure on either program. These reductions in the matching ratio correspond to budget constraints lying between afb´ and adb´.

More rigorously, the impact of this small change in ω_K^k is determined by differentiating the case 3 expenditure equation,

FIGURE 4.5

THE BUDGET CONSTRAINT AND "CLOSED-ENDED MATCHING GRANT EXPANSION PATH" FOR CHANGES IN THE MATCHING RATIO, ω_K^k, OF A CLOSED-ENDED MATCHING GRANT

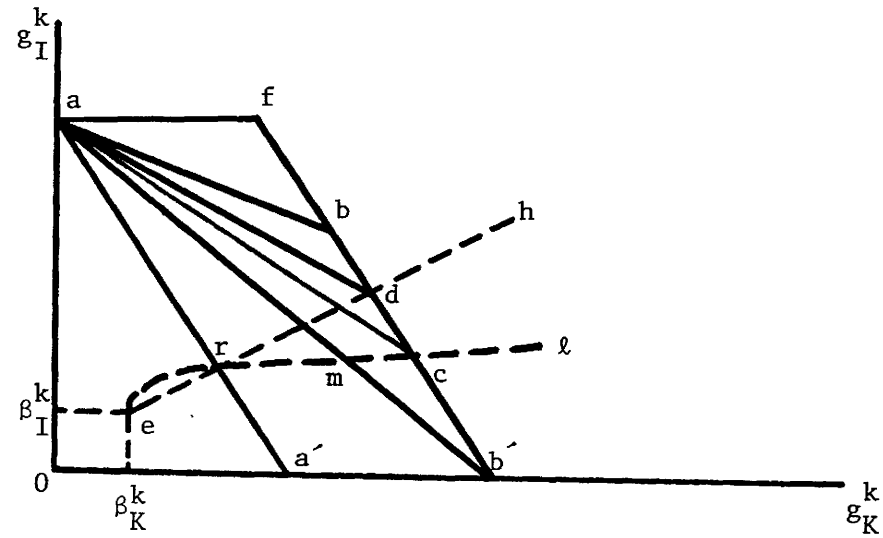
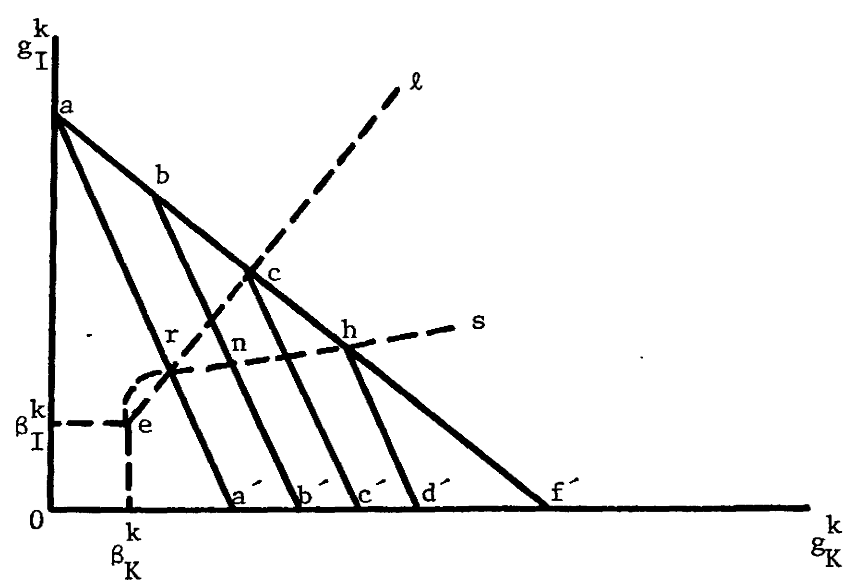


FIGURE 4.6

THE BUDGET CONSTRAINT AND "CLOSED-ENDED MATCHING GRANT EXPANSION PATH" FOR CHANGES IN THE GRANT LIMIT, $\bar{\Gamma}_{KC}^k$, OF A CLOSED-ENDED MATCHING GRANT



equation (4.10) with $\bar{\Gamma}^k_{KC}$ substituted for Γ^k_K, with respect to ω^k_K. These comparative static effects are presented in equation (4.25),

$$(4.25) \qquad \eta^{k\prime}_{PKK} = \frac{\partial(P^k_K\ g^k_K)}{\partial\omega^k_K}\Bigg|_{dP^k_K = 0} = \eta^{k\prime}_{PKI} = \frac{\partial(\partial P^k_I\ g^k_I)}{\partial\omega^k_K}\Bigg|_{dP^k_I = 0} = 0 .$$

Thus, a small change in the matching ratio of the closed-ended matching grant does not affect regional government expenditure on any program.

Alternatively, further large reductions in ω^k_K do influence government k's expenditure on each program. If the matching ratio is reduced to zero for a given $\bar{\Gamma}^k_{KC}$, the "closed-ended matching grant expansion path" for changes in ω^k_K is represented by curve dcmr in Figure 4.5. Here, the range dc corresponds to case 2 in which the grant exactly supports the aided program K. This situation suggests that the range dc of the expansion path corresponds to case 2 in which the value of the grant equals the grant limit. This case is summarized in equation (4.22a). The regional government expenditure equations for this case are presented in equations (4.22a) and (4.23). The comparative static effects of an increase in the matching ratio, ω^k_K, indicates that a change in ω^k_K induces government k to decrease consumption of the supported program, g^k_K, and increase consumption of non-supported programs, g^k_I. These comparative static results are

$$(4.26a) \qquad \eta^{k\prime}_{PKK} = \frac{\partial(P^k_K\ g^k_K)}{\partial\omega^k_K}\Bigg|_{dP^k_{K=0}} = -\frac{\bar{\Gamma}^k_{KC}}{{\omega^k_K}^2}$$

and

$$(4.26b) \qquad \eta^{k'}_{PKI} = \left.\frac{\partial(P^k_I\ g^k_I)}{\partial\omega^k_K}\right|_{dP^k_{I=0}} = \frac{b^k_I}{\sum\limits_{\substack{L=1\\ \neq K}}^{f} b^k_L} \left[\frac{\bar{\Gamma}^k_{KC}}{\omega^{k\,2}_I}\right] .$$

Here, $\eta^{k'}_{PKI}$ represents the "leakage effect" of a closed-ended matching grant. In deriving this "leakage effect," the grant limit, $\bar{\Gamma}^k_{KC}$, has remained constant. The sign of $\eta^{k'}_{PKK}$ and $\eta^{k'}_{PKI}$ in equations (4.26a) and (4.26b) indicate that in case 2 the slope of the "closed-ended matching grant expansion path" for changes in ω^k_K is negative. This is illustrated further in Figure 4.5, where the case 2 range of the expansion path, dc, is negatively sloped.

Consider the range of the "closed-ended matching grant expansion path" for ω^k_K which corresponds to case 1. Here, the grant limit, $\bar{\Gamma}^k_{KC}$, exceeds the matching funds $\omega^k_K\ P^k_K\ g^k_K$; and the binding constraint is given in equation (4.17d) where $\omega^k_I = 0$ for $I \neq K$. This range in Figure (4.5) is cr. Here, cr coincides with the "open-ended matching grant expansion path," rmcℓ, in Figure 4.5.

Thus, in case 1, the impact of a change in the matching ratio, ω^k_I, on government k's expenditure is analogous to a change in the matching ratio of an open-ended matching grant. These comparative static effects are summarized in the $\eta^{k'}_{PKI}$ and $\eta^{k'}_{PKK}$ coefficients which are identical to the γ^k_{IK} and γ^k_{KK} coefficients of an open-ended matching grant listed in equations (4.19a), and (4.19c).

$$(4.27a) \qquad \eta^{k'}_{PKK} = \gamma^{k'}_{KK}$$

$$(4.27b) \qquad \eta^{k'}_{PKI} = \gamma^{k'}_{IK}$$

From the three cases considered here, it is seen that a ragional government's expenditure response to changes in the closed-ended matching grant ratio, ω_K^k, is varied. This response depends upon two factors:

1. the magnitude of the change in, ω_K^k, and
2. the binding regional government budget constraint(s).

These comparative static results are derived on the assumption that the grant limit, $\bar{\Gamma}_{KC}^k$, is constant.

Secondly, consider the changes in regional government expenditure which are induced by changes in the closed-ended matching grant limit, $\bar{\Gamma}_{KC}^k$, for a given ω_K^k. The comparative static analysis of these changes is presented in Figure 4.6 for two programs; K, the supported program, and I, the non-supported program. Initially, regional government k faces the budget constraint abb′ which represents a closed-ended matching grant. The grant limit, expressed in terms of program K, $\bar{\Gamma}_{KC}^k/P_K^k$, is equal to a′b′. Assuming that government expenditure is described by case 3, government k consumes the combination of g_K^k and g_I^k corresponding to point n. In Figure 4.6, n lies on the "unconditional grant expansion path" eℓ. With an increase in the grant limit to a′c′, the budget constraint shifts to acc′ and government k is induced to increase its consumption of both programs in the proportions b_K^k and b_I^k.

(4.28a) $$\eta_{KK}^{k'} = \left.\frac{\partial(P_K^k\ g_K^k)}{\partial\bar{\Gamma}_{KC}^k}\right|_{dP_K^k = 0} = b_K^k$$

(4.28b) $$\eta_{KI}^{k'} = \left.\frac{\partial(P_I^k\ g_I^k)}{\partial\Gamma_{KC}^k}\right|_{dP_I^k = 0} = b_I^k$$

These relative increases in consumption are represented by the slope of the expansion path eℓ.

Consider a further increase in the grant limit to a′d′, in Figure 4.6. With this increase in the grant limit, the regional government's budget constraint shifts from acc′ to ahd′. In this event, both budget constraints are binding; the regional government is operating in accord with case 2 of the closed-ended matching grant scheme. The increase in the grant limit induces regional government k to increase consumption of program K, and reduce consumption of program I. This situation is represented graphically in Figure 4.6 by line segment ch. Point h lies on the "open-ended matching grant expansion path" erhs. More generally, this same conclusion is reached by analyzing the impact of the change in $\bar{\Gamma}^k_{KC}$ within the context of the regional government expenditure equations, equations (4.22a) and (4.23). The impact of this increase in $\bar{\Gamma}^k_{KC}$ on government k's expenditure on the supported program, $P^k_K\, g^k_K$, and non-supported programs, $P^k_I\, g^k_I$, is described by equations (4.29a) and (4.29b), respectively.[9]

$$(4.29a) \qquad \eta^{k\prime}_{KK} = \left.\frac{\partial(P^k_K\, g^k_K)}{\partial\, \bar{\Gamma}^k_{KC}}\right|_{dP^k_K=0} = \frac{1}{\omega^k_K}$$

$$(4.29b) \qquad \eta^{k\prime}_{KI} = \left.\frac{\partial(P^k_I\, g^k_I)}{\partial\, \bar{\Gamma}^k_{KC}}\right|_{dP^k_I=0} = -\frac{b^k_I}{\sum\limits_{\substack{L=1\\ \neq K}}^{f} b^k_L}\left(\frac{1-\omega^k_K}{\omega^k_K}\right).$$

Equation (4.29b) illustrates that an increase in the grant limit, $\bar{\Gamma}^k_{KC}$, reduces regional government expenditure on non-supported programs.

This reduction in non-supported program expenditure is referred to as the "seepage effect" of a closed-ended matching grant (Wilde, 1968).

Finally, consider a further increase in the grant limit beyond a´d´ in Figure 4.6. The regional government is consuming at point h on the "open-ended matching grant expansion path," erhs. In this situation, the only binding constraint is line af´ in Figure 4.6 which is summarized in equation (4.17d). The regional government is in a situation which is described by case 1 of a closed-ended matching grant. For a regional government with this consumption behavior, an increase in the grant limit beyond a´d´ will not induce the regional government to alter its expenditure on programs K and I. This is obvious when the regional government expenditure equations, equation (4.18), are considered. Differentiating (4.18) with respect to $\bar{\Gamma}^k_{KC}$, the impact of this increase in the grant limit on regional government expenditure is determined. These comparative static effects are

$$(4.30a) \qquad \eta^{k'}_{KK} = \left.\frac{\partial(P^k_K\, g^k_K)}{\partial\bar{\Gamma}^k_{KC}}\right|_{dP^k_K = 0} = 0$$

and

$$(4.30b) \qquad \eta^{k'}_{KI} = \left.\frac{\partial(P^k_I\, g^k_I)}{\partial\bar{\Gamma}^k_{KC}}\right|_{dP^k_K = 0} = 0.$$

Thus, the "closed-ended matching grant expansion path" for changes in the grant limit given a constant matching ratio is curve nch in Figure 4.6.

The preceding analysis indicates there is a monotonic relationship between regional government k's expenditure on the supported program K and the grant limit, $\bar{\Gamma}^k_{KC}$. However, this relationship does not hold for expenditure on non-supported programs.

In summary, closed-ended matching grants have been analyzed within the framework of three cases:

1. expenditure on the supported program is less than the weighted grant limit,
2. expenditure on the supported program exactly equals the weighted grant limit, and
3. expenditure on the supported program exceeds the weighted grant limit.

It has been demonstrated that regional government expenditure responses to changes in either of the grant parameters, ω^k_K and $\bar{\Gamma}^k_K$, are diverse. For example, an increase in the matching ratio, ω^k_K, will induce regional government k to:

1. increase expenditure on the supported program, K, if case 1 is binding,
2. decrease expenditure on program K if case 2 is binding,
3. not alter expenditure on any program if case 3 is binding, and
4. increase expenditure on non-supported programs if cases 1 or 2 are binding.

Similarly, it has been demonstrated that an increase in the grant limit will induce a regional government to:

1. increase expenditure on the supported program if cases 2 or 3 are binding,

2. increase expenditure on non-supported program if case 3 is binding,

3. reduce expenditure on non-supported program if case 2 is binding, and

4. not alter expenditure on any program if case 1 is binding.

This taxonomic summary of the impact of marginal changes in $\bar{\Gamma}^k_{KC}$ and ω^k_K concludes the presentation of closed-ended matching grants.

4.6. Conclusion and Summary of Response Coefficients

A behavioral model of regional government expenditure has been developed in this chapter. In this model, each regional government is assumed to maximize a Stone-Geary utility function subject to a set of budget constraints. The form of each set of budget constraints and the resulting regional government expenditure functions are determined by the type of federal grant extended to the regional government. In all cases, it is assumed that regional government non-grant revenue is exogenous. The analysis indicates a number of possible responses to changes in four grant parameters; the value of unconditional grants, the value of conditional non-matching grants, the value of closed-ended matching grant limits, and the value of open- and closed-ended matching grant ratios. In summary, these responses are:

1. An increase in an unconditional grant, $\bar{\Gamma}^k$, a conditional non-matching grant, case 1, $\bar{\Gamma}^k_K$, and a closed-ended matching grant limit, case 3, $\bar{\Gamma}^k_{KC}$, induce regional government k to increase expenditure on all programs by a constant proportion b^k_I,I=1,K,...,f. These proportions are the η^k_I, I=1,...,f, coefficients in equation (4.5).

2. An increase in a conditional non-matching grant, case 2, $\bar{\Gamma}^k_K$, induces regional government k to increase expenditure on the supported program, K, by the full value of the grant increase. Expenditure on other programs remains unchanged. This response is summarized in the γ^k_K and γ^k_I coefficients of equations (4.14a) and (4.14b).

3. Increases in a closed-ended matching grant limit, case 2, $\bar{\Gamma}^k_{KC}$, induce government k to increase expenditure on the supported program by $1/\omega^k_K$ and reduce expenditure on each non-supported program by a constant proportion,

$$\frac{b^k_I}{\sum\limits_{L\neq K} b^k_L}\ [\frac{1-\omega^k_K}{\omega^k_K}],$$

of the increase in the grant limit. These changes in expenditure are summarized by the $\eta^{k'}_{KK}$ and $\eta^{k'}_{KI}$ coefficients in equations (4.29a) and (4.29b).

4. An increase in a closed-ended matching grant limit, case 1, does not induce the regional government to alter expenditure on any program.

5. An increase in the matching ratio of an open-ended matching grant and a closed-ended matching grant, case 1, ω^k_K, induces regional government k to increase expenditure on both the supported program and the non-supported program by

$$\frac{b^k_K}{(1-\omega^k_K)^2}\ [\bar{\Gamma}^k - \sum_{L=1}^{f} (1-\omega^k_L) P^k_L\ \beta^k_L] + \frac{\beta^k_K P^k_K b^k_K}{(1-\omega^k_K)},\ \text{and}\ \frac{b^k_I P^k_K \beta^k_K}{(1-\omega^k_I)},$$

respectively. These increases in expenditure are summarized in the $\gamma_{KK}^{k'}$ and $\gamma_{KI}^{k'}$ terms of equations (4.19a) and (4.19b).

6. Increases in the matching ratio of a closed-ended matching grant, case 2, induces government k to reduce expenditure on the supported program by $\frac{\bar{\Gamma}_{KC}^{k}}{\omega_{K}^{k^2}}$ and to increase expenditure on the supported program by $\frac{b_I^k}{\sum_{L \neq K} b_L^k} [\frac{\bar{\Gamma}_{KC}^{k}}{\omega_{I}^{k^2}}]$. These values are summarized in the $\eta_{PKK}^{k'}$ and $\eta_{PKI}^{k'}$ terms of equations (4.26a) and (4.26b).

This summary of the effects of changes in the four federal grant parameters indicates the extent that variations in federal grants influence regional government expenditure. In the next chapter, an I-O model which emphasizes the production and income effects of grant induced regional government expenditure is presented.

Footnotes to Chapter 4

[1]This classification of federal grants is consistent with the structure of federal-provincial grants in Canada during the 1947-1965 period.

[2]Residents' preferences for programs are, however, reflected in the minimum acceptable levels of programs, β_I, $I = 1,\dots,f$.

[3]The Stone-Geary utility function is chosen for two reasons:

a) the linear expansion paths for consumption out of supernumerary income is compatible with I-O analysis; and

b) the minimum level of program expenditure, $P_K^k\beta_K^k$, reflects a political constraint which may influence the expenditure behavior of regional governments.

A Stone-Geary utility function is employed by Slack to analyze local government response to provincial grants.

[4]Indifference curves for a Stone-Geary utility function are defined only for the space where $g_I^k > \beta_I^k$, $I = 1,\dots,f$. In addition, the income expansion path is linear, thus, the indifference curves are homothetic to the point $(\beta_1^k,\dots,\beta_I^k,\dots,\beta_f^k)$. The set of expenditure functions derived from this utility function is referred to as the Linear Expenditure System.

[5]The assumption of exogenous regional government non-grant revenue is a simplification. A more realistic model of regional government expenditure could be formulated by considering regional government non-grant revenue as an endogenous variable. For example, one possible formulation of this type of model is to include regional government revenue from own taxation and borrowing in the regional government decision-maker's utility function. Here, the marginal utility of revenue from own taxes and borrowing is negative. Thus, in maximizing his utility, the regional government decision-maker chooses the optimal combination of programs and the optimal level of revenue from own taxation and borrowing. This model is a simplified optimal tax model with lump sum taxes and borrowing. The optimal tax model is not developed in this thesis because it focuses attention on issues other than the fundamental problem addressed in this thesis--the regional income distribution effects of federal grants.

[6]One special case of the matching ratio needs to be discussed. If $\omega_K^k = 1$, the open-ended matching grant corresponds to a conditional non-matching grant. The analysis in Section 4.3 suggests that the regional government would demand an infinite amount of the supported program. Thus, grants of this type are not used for obvious reasons.

[7]Throughout this analysis, it is assumed that only program K is supported by a grant. If all programs were supported, the most general analysis would require consideration of twelve cases.

[8]If $\omega_K^k = 1$, the closed-ended matching grant is equivalent to a conditional non-matching grant of $\bar{\Gamma}_K^k = \bar{\Gamma}_{KC}^k$. In Figure 4.5, the budget constraint is afb´. Also, sufficiently large decreases in ω_K^k result in a situation in which the grant limit is ineffective. This event corresponds to all budget constraints with a slope less than aa´ and greater than ab´ in Figure 4.5. For each of these ω_K^k values, the relation

$$g_K^k \leq \frac{\Gamma^k}{(1-\omega_K^k)P_K^k} < \frac{\Gamma^k+\bar{\Gamma}_{KC}}{P_K^k}$$

holds.

[9]It is interesting to note that in case 2, an equal percentage change in $\bar{\Gamma}_{KC}^k$ and ω_K^k leaves expenditure on the supported program, $P_K^k\, g_K^k$, unchanged.

CHAPTER 5

AN INTERREGIONAL INPUT-OUTPUT MODEL OF A FEDERAL SYSTEM

5.1 Introduction

In this chapter, a theoretical model of the economic interaction of regions within a decentralized federal system is developed. The format for this model is two interregional Input-Output (I-0) models which differ in their treatment of the personal consumption sector. Both I-0 models emphasize the industrial composition of regional government final demand. Applying standard techniques of I-0 analysis, changes in regional government final demand are converted into interregional production effects and employment income effects. Thus, the impact of changes in federal grants are derived.

The assumptions of the I-0 models are stated in Section 5.2. In Sections 5.3, 5.4, and 5.5, the I-0 models are presented. In Section 5.6, the regional government fiscal response to federal grants which were derived in Chapter 4 are incorporated into the I-0 model. The production effects and employment income effects of federal grants are described in Section 5.7. Section 5.8 presents a brief summary of the model.

5.2 Assumptions of the Input-Output Model

The following assumptions are necessary to construct the interregional I-0 model:

(i) There are n industrial sectors in each of m regions. Each industrial sector produces a single homogeneous product.

(ii) All markets are perfectly competitive.

(iii) All production functions have zero elasticity of substitution. This implies fixed coefficient production functions of the form

$$x_i = \min \left[\frac{x_{1i}}{a_{1i}}, \ldots, \frac{x_{ni}}{a_{ni}}, \frac{w_i}{a_{wi}}, \frac{v_i}{a_{vi}}\right],$$

$$i = 1, \ldots, n,$$

$$a_{ki} \geqq 0,$$

where w_i and $v_i \equiv$ primary inputs,

and $x_{ki} \equiv$ intermediate inputs, $k = 1, \ldots, n$.

This production function implies constant returns to scale (homogenous of degree one). All industries operate with no excess inputs, thus the marginal product of each input is equal to its average product.

(iv) There are no external economies or diseconomies in the production process.

(v) No goods are jointly produced.

(vi) Factor prices are constant over all ranges. With assumption (iii), this implies there are no capacity constraints. The supply of x_i is infinitely elastic.[1]

(vii) Trade coefficients are constant. Consequently, market shares are constant for all sectors in all regions.

(viii) Labour is not mobile between regions.

(ix) All consumers have identical Cobb-Douglas utility functions. Thus, personal consumption is a linear function of personal disposable income where the average propensity to consume equals the marginal propensity to consume.

(x) Profits to industrialists are not distributed to households.[2]

(xi) Expenditure decisions made by any one regional government are independent of the behavior of all other regional governments.

(xii) At given prices, all markets are in equilibrium.

5.3 The Interregional Income Accounting System

The Basic and Keynesian-Leontief I-0 models developed in this chapter represent stylized regional accounting systems drawn from a more complete and detailed income accounting system of the interregional economy under consideration. Although this study is not specifically concerned with the development and analysis of such an accounting system, the interregional income accounting system provides a framework for the subsequent analysis of the regional income effects of federal grants to regional governments. The interregional income accounting system presents all economic sectors and indicates the economic interactions between sectors and between regions. Moreover, this accounting system indicates the significance of the I-0 accounting identities and facilitates the explanation of these identities which is presented in Sections 5.4 and 5.5.

This interregional accounting system is now described. For accounting purposes, each regional economy is decomposed into four sectors: industries, X, personal consumption, C, regional government, G, and other final demand, F. A schematic representation of the interregional income accounting system is presented in Figure 5.1 where all column sum values are given in current market prices. In this figure, superscripts denote regions and subscripts denote industries. Thus, the superscript "rk" indicates the flow of commodities or services, from region r to region k. Similarly, subscript "ij" indicates a flow from sector i to sector j. It is assumed that households and other primary inputs earn income only in the region where they are physically located. In addition, regional government taxes (and subsidies) are imposed only on domestic firms. The pattern of non-zero coefficients in the primary input rows of Figure 5.1 reflects these assumptions.

This system of accounting is concisely and accurately interpreted and explained through consideration of four accounting principles:

1. The cost-profit identity which must hold for each industry in each region,
2. The demand-supply equation which must hold for the output of each industry in each region,
3. The gross domestic income at factor prices accounting identity which must hold for all m regions,
4. The gross domestic income at market prices accounting identity which must hold for all m regions.

For expository purposes these four identities will be derived with respect to industry 1 in region 1 or for region 1, whichever is appropriate. However, the identities are completely general and they apply to any industry or region.

First, consider the cost-profit identity for industry 1 in region 1. The amount which accrues to other primary inputs, v_1^1, from production by industry 1 is obtained by subtracting the sum of

a. the domestic and imported inputs bought by industry 1 in region 1 for current production,

$$\sum_{i=1}^{n} x_{i1}^{11} + \sum_{k=2}^{m} \sum_{i=1}^{n} x_{i1}^{k1} ;$$

b. the wage bill paid to domestic labour employed by industry 1 in region 1,

$$w_1^1 ;$$

and

c. the difference between domestic regional government taxes on expenditures made by industry 1 of region 1 and the subsidies paid to the same industry,

$$\tau_1^1 - s_1^1 ;$$

from

d. the total output of industry 1 in region 1,

$$x_1^1 .$$

If the only component of other primary inputs is the gross return to industrialists,

$$(5.1) \qquad v_1^1 = x_1^1 - \sum_{k=1}^{m} \sum_{i=1}^{n} x_{i1}^{k1} - w_1^1 - (\tau_1^1 - s_1^1)$$

is the cost-profit identity of industry 1 in region 1. This identity must hold for each industry, i=1,...,n, in each region, k=1,...,m. Rearranging (5.1) for all j,j=1,...,n, the cost-profit identity is restated as the appropriate column sum in Figure 5.1,

$$(5.2) \qquad x_j^1 = \sum_{k=1}^{m} \sum_{i=1}^{n} x_{ij}^{k1} + w_j^1 + (\tau_j^1 - s_j^1) + v_j^1 , \qquad j=1,\dots,n .$$

Second, consider the demand-supply equation for industry 1 in region 1. By summing

a. the domestic and "foreign" intermediate demand for the output of industry 1 in region 1,

$$\sum_{j=1}^{n} x_{1j}^{11} + \sum_{k=2}^{m} \sum_{j=1}^{n} x_{1j}^{1k} ,$$

b. domestic and "foreign" consumer demand for output of industry 1 in region 1,

$$c_1^{11} + \sum_{k=2}^{m} c_1^{1k} ,$$

c. domestic and foreign governments' demand for output of industry 1 in region 1,

$$g_1^{11} + \sum_{k=2}^{m} g_1^{1k} ,$$

and

d. domestic and "foreign" other final demand for the output of industry 1 in region 1,

$$f_1^{11} + \sum_{k=2}^{m} f_1^{1k} ,$$

total demand for the output of industry 1 in region 1 is obtained.

This total demand must equal the total output of industry 1 in region 1, x_1^1,

$$(5.3)\qquad x_1^1 = \sum_{k=1}^{m} \sum_{j=1}^{n} x_{1j}^{1k} + \sum_{k=1}^{m} c_1^{1k} + \sum_{k=1}^{m} g_1^{1k} + \sum_{k=1}^{m} f_1^{1k} .$$

The definition of other final demand in equation (5.3) is important in establishing this equality. Other final demand includes investment and inventory adjustments.

A demand-supply equation, similar to equation (5.3), must hold for all industries $i, i=1,\ldots,n$, in all regions $r, r=1,\ldots,m$. The two definitions of regional income; gross domestic income at factor prices and gross domestic income at market prices, are now defined in terms of interindustry and interregional flows of goods and services.

Following Rosen (1972, pp. 176-180), total demand of all sectors in region 1 is calculated as the sum of total demand in all industries, $i=1,\ldots,n$, (equation 5.3) and the value of demand by the autonomous primary sectors, e.g., labour, government, and other primary inputs, in region 1. Thus, the total demand in region 1 which represents the total of all row sums for region 1 in Table 5.1 is

$$(5.4a)\qquad X^1 = \sum_{i=1}^{n} [\sum_{k=1}^{m} \sum_{j=1}^{n} x_{ij}^{1k} + \sum_{k=1}^{m} (c_i^{1k} + g_i^{1k} + f_i^{1k})] + \sum_{i=1}^{n} [\sum_{k=2}^{m} \sum_{j=1}^{n} x_{ij}^{k1} +$$

$$\sum_{k=2}^{m} (c_i^{k1} + g_i^{k1} + f_i^{k1})] + \sum_{i=1}^{n} [w_i^1 + (\tau_i^1 - s_i^1) + v_i^1] + \sum_{i=C,G,F} w_i^1 .$$

This value of total demand in region 1 is equal to the value of total outlay in region 1. Thus, X^1 also equals the sum of all inputs in intermediate and final uses. In equation (5.4b), the value of total outlay in region 1 is presented in a form similar to equation (5.2),

$$(5.4b) \qquad X^1 = \sum_{j=1}^{n} [\sum_{k=1}^{m} \sum_{i=1}^{n} x_{ij}^{1k} + \sum_{k=1}^{m} (c_j^{1k} + g_j^{1k} + f_j^{1k})] + \sum_{j=1}^{n} [\sum_{k=2}^{m} \sum_{i=1}^{n} x_{ij}^{k1} +$$

$$\sum_{k=2}^{m} (c_j^{k1} + g_j^{k1} + f_j^{k1})] + \sum_{i=1}^{n} [w_i^1 + (\tau_i^1 - s_i^1) + v_i^1] +$$

$$\sum_{i=C,G,F} [w_i^1 + (\tau_i^1 - s_i^1)] \; .$$

Equation (5.4b) represents the total of all column sums for region 1 in Table 5.1.

The net domestic output in region 1, X^{*1}, is defined as that part of total output required to satisfy total demand in region 1, equation (5.4a), which remains after

1. domestic output and primary inputs (excluding government) which are consumed by industries in region 1 for current production,

$$\sum_{i=1}^{n} \sum_{j=1}^{n} x_{ij}^{11} + \sum_{i=1}^{n} [w_i^1 + v_i^1] \; ;$$

and

2. imports which are consumed by industries in region 1 for current production,

$$\sum_{k=2}^{m} \sum_{i=1}^{n} \sum_{j=1}^{n} x_{ij}^{k1} \; ,$$

are deducted. Alternatively, from Figure 5.1, domestic net output in region 1 is represented as

$$(5.5) \qquad X^{*1} = C^{*1} + G^{*1} + F^{*1} + (E^1 - M^1),$$

where

$$C^{*1} = \sum_{i=1}^{n} c_i^{11} + \sum_{k=2}^{m} \sum_{i=1}^{n} c_i^{k1} + w_c^1 , \tag{5.6a}$$

$$G^{*1} = \sum_{i=1}^{n} g_i^{11} + \sum_{k=2}^{m} \sum_{i=1}^{n} g_i^{k1} + w_G^1 , \tag{5.6b}$$

and

$$F^{*1} = \sum_{i=1}^{n} f_i^{11} + \sum_{k=2}^{m} \sum_{i=1}^{n} f_i^{k1} + w_f^1 . \tag{5.6c}$$

C^{*1}, G^{*1}, and F^{*1} represent the total final demands in region 1 which include demand for both domestic and imported goods and services, and the direct use of primary inputs. Also, E^1 represents region 1's total exports,

$$E^1 = \sum_{k=2}^{m} \sum_{i=1}^{n} \sum_{j=1}^{n} x_{ij}^{1k} + \sum_{k=2}^{m} \sum_{i=1}^{n} c_i^{1k} + \sum_{k=2}^{m} \sum_{i=1}^{n} g_i^{1k} + \sum_{k=2}^{m} \sum_{i=1}^{n} f_i^{1k}, \tag{5.6d}$$

and M^1 represents region 1's total imports,

$$M^1 = \sum_{k=2}^{m} \sum_{i=1}^{n} \sum_{j=1}^{n} x_{ij}^{k1} + \sum_{k=2}^{m} \sum_{i=1}^{n} c_i^{k1} + \sum_{k=2}^{m} \sum_{i=1}^{n} g_i^{k1} + \sum_{k=2}^{m} \sum_{i=1}^{n} f_i^{k1} . \tag{5.6e}$$

The two income accounting formulae may now be developed. X^{*1} includes net expenditure taxes on industrial transactions; therefore, gross domestic regional income at factor prices, X_f^1, is obtained for region 1 by subtracting $\sum_{i=1}^{n} (\tau_i^1 - s_i^1)$ from X^{*1}, such that

$$X_f^1 = C^{*1} + G^{*1} + F^{*1} + (E^1 - M^1) - \sum_{i=1}^{n} (\tau_i^1 - s_i^1) . \tag{5.7a}$$

From (5.4b), gross domestic regional income at factor prices is

$$X_f^1 = \sum_{j=1}^{n} [w_j^1 + v_j^1] + \sum_{i=C,G,F} w_i^1 . \tag{5.7b}$$

By expressing region 1's total final demands in market prices such that

(5.8a) $$C^1 = C^{*1} + (\tau_C^1 - s_C^1) ,$$

(5.8b) $$G^1 = G^{*1} + (\tau_G^1 - s_G^1) ,$$

and

(5.8c) $$F^1 = F^{*1} + (\tau_F^1 - s_F^1) ,$$

and then substituting for C^{*1}, G^{*1}, and F^{*1} in (5.7a), the familiar regional income at factor prices accounting identity emerges:

(5.9) $$X_f^1 = C^1 + G^1 + F^1 + (E^1 - M^1) - (\tau^1 - S^1) ,$$

where

(5.10) $$(\tau^1 - S^1) = \sum_{i=1}^{n} (\tau_i^1 - s_i^1) + \sum_{i=C,G,F} (\tau_i^1 - s_i^1) .$$

Finally, the regional income at market prices accounting identity for region 1 is derived from equation (5.5). Domestic net regional output in region 1, X^{*1}, does not include net expenditure taxes, $(\tau_C^1 - s_C^1)$, $(\tau_G^1 - s_G^1)$, and $(\tau_F^1 - s_F^1)$. Adding these components to X^{*1}, domestic gross regional income at market prices, X_m^1, is defined as

(5.11) $$X_m^1 = C^{*1} + G^{*1} + F^{*1} + (E^1 - M^1) + \sum_{i=C,G,F,} (\tau_i^1 - s_i^1) .$$

Substituting the final demands at market prices given in equations (5.8a), (5.8b), and (5.8c) for C^{*1}, G^{*1}, and F^{*1} in equation (5.11), the familiar regional income at market prices accounting identity,

(5.12) $$X_m^1 = C^1 + G^1 + F^1 + (X^1 - M^1),$$

emerges for region 1.

The two regional income accounting identities, presented in equations (5.9) and (5.12), can be developed for each of the m regions represented in the schematic accounting system of Figure 5.1.

Four accounting identities have been developed in this section. Each identity:

1. the cost-profit identity,
2. the set of demand-supply equations,
3. the regional income at factor prices accounting identity, and
4. the regional income at market prices accounting identity,

explicitly describes one aspect of regional economic interactions. These accounting identities describe the context within which the regional income effects of federal grants are analyzed. The income accounting system is the basis of the I-O model which provides a general framework for analyzing federal grants.

5.4 A Basic Input-Output Model

The interregional income accounting system, discussed in Section 5.3, can be organized and interpreted as an I-O model of the interregional economy. In this section, an open interregional I-O model, referred to as the Basic I-O model is presented. After establishing the general relationship between the income accounting system and the I-O model, individual matrices of the Basic I-O model are discussed. This discussion concentrates on defining the I-O matrices and interpreting them within the context of the interregional income accounting system. The distinguishing characteristic of the Basic I-O model is that all final demand sectors; personal consumption, regional government, and other final demand, are exogenous.

The foundation of the Basic I-O model is the set of mn demand-supply equations generalized from equation (5.3), to define

$$(5.13) \quad x_i^k = \sum_{r=1}^{m} \sum_{j=1}^{n} x_{ij}^{kr} + \sum_{r=1}^{m} c_i^{kr} + \sum_{r=1}^{m} g_i^{kr} + \sum_{r=1}^{m} f_i^{kr} \qquad \begin{array}{l} i=1,\ldots,n \\ k=1,\ldots,m. \end{array}$$

Expressing the system of equations represented by equation (5.13) in a matrix-vector format,[3] the I-O accounting balance equation emerges.[4]

$$(5.14) \quad \underline{X} = \underline{\underline{T}}\,\hat{\underline{\underline{A}}}\,\underline{X} + \underline{\underline{T}}\,\underline{C} + \underline{\underline{T}}\,\underline{G} + \underline{\underline{T}}\,\underline{F}$$

The significance of this representation of the interregional economy for the study of federal grants is discussed in Section 5.4.2. Before this discussion it is necessary to define the individual components of the I-O accounting identity presented in equation (5.14).

5.4.1 Definitions

In this section, components of the I-O accounting identity are defined. First, the supply side of the model is briefly discussed. Following the discussion of the supply side, the demand side of the model is presented in two parts; intermediate demand, and final demand.

The Supply of Total Output

Consider the supply of total output in the I-O model summarized in equation (5.14). In this representation of the interregional economy, $\underline{X} = [x_i^k]$ is a mn x 1 column vector of total output, at market prices, of each industry in each region. The elements of this vector are arranged by region. Thus, $\underline{X}$ represents the first mn row sums in Figure 5.1.

The Demand For Total Output

Discussion of the demand side of the interregional I-O model is more involved than the discussion of the supply side. The demand for total output, the right-hand side of equation (5.14), is decomposed into two types of demand; intermediate demand, and final demand. These demands are now discussed.

Intermediate Demand: Consider the intermediate demand for output $\underline{X}$. The first term on the right-hand side of (5.14) $\underline{\underline{T}}\ \hat{\underline{\underline{A}}}\ \underline{X}$, summarizes the domestic and imported inputs demanded by each industry in each region for current production. This industry demand, which is referred to as intermediate demand, is endogenous. In equation (5.14), the intermediate demand term contains two sets of data which form the foundations of the interregional I-O model. Each data set is composed of individual elements which remain constant through time. The first set of constants, the interindustry flow coefficients, is summarized in the mn x mn block diagonal matrix $\hat{\underline{\underline{A}}}$. Each matrix on the diagonal is an n x n matrix $\underline{\underline{A}}^k = [a^k_{ij}]$. Elements of $\hat{\underline{\underline{A}}}$, a^k_{ij}, indicate the amount of the i^{th} industry's output needed to produce one dollar's worth of output in the j^{th} industry in region k, i.e.,

$$(5.15a) \qquad a^k_{ij} = \frac{x^k_{ij}}{\sum_{i=1}^{n} x^k_{ij} + w^k_i + (\tau^k_i - s^k_i) + v^k_i},$$

where $0 \leq a^k_{ij} < 1$,

and $\sum_{i=1}^{n} a^k_{ij} < 1$.

Thus, the matrix $\underline{\underline{A}}^k$ describes the state of technology in region k.

The second set of constants, the regional trade coefficients, are described in the matrix of trade coefficients, $\underline{\underline{T}}$. $\underline{\underline{T}} = [\hat{\underline{\underline{T}}}^{rk}]$ is a mn x mn matrix with m^2 sets of nxn diagonal matrices, $\hat{\underline{\underline{T}}}^{rk}$. Each $\hat{\underline{\underline{T}}}^{rk} = [t_i^{rk}]$ matrix has diagonal elements which represent the flow of output of industry i from region r to region k per dollar of output of industry i demanded in region k. Each t_i^{rk} is a Chenery-Moses type trade coefficient of the form

$$\text{(5.15b)} \qquad t_i^{rk} = \{ \sum_{j=1}^{n} x_{ij}^{rk} + h_i^{rk} \} \Big/ \{ \sum_{r=1}^{m} \sum_{j=1}^{n} x_{ij}^{rk} + \sum_{r=1}^{m} h_i^{rk} \} ,$$

where

$$\text{(5.15c)} \qquad h_i^{rk} = c_i^{rk} + g_i^{rk} + f_i^{rk}$$

is total final demand. Thus, t_i^{rk} is the same for all sectors in region r which consume output from industry i. The trade coefficient matrix, $\underline{\underline{T}}$, is presented schematically in Appendix A.

The product of the trade coefficient matrix and the industry flow coefficient matrix, $\underline{\underline{T}}\,\hat{\underline{\underline{A}}} = [t_i^{rk}\, a_{ij}^k]$, is the I-O matrix of intermediate demand coefficients. A typical element of this matrix, $[t_i^{rk}\, a_{ij}^k]$, indicates the amount of output from the i^{th} industry in region r used to produce one dollar's worth of output in the j^{th} industry in region k. There is a one to one correspondence between each element of $\underline{\underline{T}}\,\hat{\underline{\underline{A}}}$, $[t_i^{rk}\, a_{ij}^k]$, and each x_{ij}^{rk} component of the regional income accounting system. $\underline{\underline{T}}\,\hat{\underline{\underline{A}}}$ represents the amount of domestic and imported inputs purchased for current production in per-dollar coefficients. Thus, this matrix corresponds to the first mn rows and columns of the interregional income accounting system which describes flows between industries.

Final Demand: Finally, consider the last three terms on the right-hand side of equation (5.14), $\underline{\underline{T}}\ \underline{C}$, $\underline{\underline{T}}\ \underline{G}$, and $\underline{\underline{T}}\ \underline{F}$. These mn x 1 column vectors represent the final demand sectors of the m region economy. In the basic I-O model, all final demands are exogenous.

A. Consumption: Consider first, the interregional I-O personal consumption vector $\underline{\underline{T}}\ \underline{C} = [\sum_{k=1}^{m} t_i^{rk} c_i^k]$. This vector is formed from two sets of data; the total personal consumption expenditure for the output of each industry in each region, the $\underline{C}$ vector, and the trade coefficients contained in $\underline{\underline{T}}$.

Turning to the personal consumption vector, $\underline{C}$, this vector is formed from the product of:

1. an average propensity to consume matrix, and
2. a personal income vector, i.e.,

$$\text{(5.15d)} \qquad \underline{C} = \hat{\underline{\underline{c}}}\ \underline{N} = [c_i^k] = [\sum_{k=1}^{m} b_i^k \nu^k] ,$$

where $\hat{\underline{\underline{c}}}$ is a mn x m block diagonal matrix of average propensities to consume from personal income. Each block on the diagonal of $\hat{\underline{\underline{c}}}$, $\underline{c}^k = [b_i^k]$, is a nxl column vector of average propensities to consume output from industry i, i=1,...,n, from personal income, ν^k, in region k. The matrix of average propensities to consume, $\hat{\underline{\underline{c}}}$, is presented schematically in Appendix A. Personal incomes are arranged by region in the mxl column vector $\underline{N} = [\nu^k]$. The behavioral theory of personal consumption expenditure from which the b_i^k coefficients are derived, is presented in Section 5.5.

The interregional flow of commodities required to satisfy personal consumption final demands is described by elements of the trade coefficient matrix, $\underline{\underline{T}}$, which premultiplies $\underline{C}$. Elements of the interregional I-O personal consumption vector, $\underline{\underline{T}}\underline{C}$, are arranged in a regional ordering. This vector presents the personal consumption data recorded in the interregional income accounting system (Figure 5.1),

$$(5.16a) \qquad c_i^{rk} = t_i^{rk} c_i^k , \quad i=1,\ldots,n, \quad r,k = 1,\ldots,m.$$

Aggregating the personal consumption final demand in all regions, k,k=1, ...,m, which is satisfied by industry i, i=1,...,n, in region r, r=1,...,m, c_i^{rk}, the interregional I-O personal consumption values are derived. The value for the i^{th} industry in region r is summarized in equation (5.16b),

$$(5.16b) \qquad \sum_{k=1}^{m} c_i^{rk} = \sum_{k=1}^{m} t_i^{rk} c_i^k .$$

B. Regional Government: Next, consider regional government final demands, $\underline{\underline{T}}\ \underline{G} = [\sum_{k=1}^{m} t_i^{rk} g_i^k]$. This column vector represents the demand by each regional government for the output of each industry in each region. Elements of $\underline{G}$, g_i^k, indicate the value of output from industry i required by regional government k for the provision of a given level of government programs. The behavioral model of regional government expenditure is presented in Chapter 4. The $\underline{\underline{T}}\ \underline{G}$ vector summarizes the regional government final demand data contained in the interregional income accounting system (Figure 5.1), (5.17a) $$g_i^{rk} = t_i^{rk} \; g_i^k \, ,$$

$i=1,\ldots,n,$

$r,k=1,\ldots,m.$

In the I-O model, this vector is arranged in a regional ordering. The regional ordering of this final demand component is obtained by aggregating the interregional flow of commodities represented in equation (5.17a) according to their region of destination. Thus, a typical element of $\underline{\underline{T}}\ \underline{G}$ is described by equation (5.17b),

(5.17b) $$\sum_{k=1}^{m} g_i^{rk} = \sum_{k=1}^{m} t_i^{rk} \; g_i^k \, .$$

C. Other Final Demand: The third component of the final demand sector is the vector of other final demand expenditure $\underline{\underline{T}}\ \underline{F}$. Unlike the personal consumption and regional government components of final demand, other final demand expenditures are expenditures which are not explained behaviorally. For this reason, the other final demand sector is presented in greater detail in this section.

There are K other final demand categories in this model which describe demand for industrial output from each region and include investment and inventory changes. The other final demand sector, $\underline{\underline{T}}\ \underline{F} = [\sum_{k=1}^{m} t_i^{rk} \; f_i^k]$, is formed from two components; the trade coefficient matrix, $\underline{\underline{T}}$, and the mn x 1 column vector of other final demand dollar values, $\underline{F}$. This vector of other final demand dollar values is itself the product of two components; the matrix of final demand coefficients, $\hat{\underline{\underline{F}}}'$, and the vector of other final demand expenditures, $\underline{Z}$. Thus the other final demand dollar values, $\underline{F}$, are defined as

$$(5.18) \qquad \underline{F} = \underline{\underline{\hat{F}'}} \; \underline{Z} = [\sum_{F=1}^{K} f_{Fi}^{k'} \; z_F^k] \; ,$$

k=1,...,m,

i=1,...,n,

where $\underline{\underline{\hat{F}'}} = [\underline{\underline{F}}^{k'}]$ is a mn x mK block diagonal matrix. Each $\underline{\underline{F}}^{k'} = [f_{Fi}^{k'}]$ matrix on the diagonal is a nxK matrix of other final demand coefficients. This matrix converts categories of other final demand to industry final demands. The other final demand matrix, $\underline{\underline{\hat{F}'}}$, is presented schematically in Appendix A. $\underline{Z} = [z_F^k]$ is a mK x 1 column vector of other final demand expenditures in each region.

The other final demand vector, $\underline{\underline{T}} \; \underline{F}$, is arranged by industry. This vector summarizes the other final demand data of the interregional income accounting system (Figure 5.1),

$$(5.19a) \qquad f_i^{rk} = t_i^{rk} \; f_i^k \; ,$$

i=1,...,n,

r,k=1,...,m.

The regional ordering is obtained by summing each of these commodity flows, f_i^{rk}, over the regions of destination, k. A typical element of the $\underline{\underline{T}} \; \underline{F}$ vector is described by equation (5.19b),

$$(5.19b) \qquad \sum_{k=1}^{m} f_i^{rk} = \sum_{k=1}^{m} t_i^{rk} \; f_i^k \; .$$

Although this sector is not explained behaviorally, its importance in the I-O model should not be understated. Since inventory adjustment is included in the other final demand sector, it plays a crucial role in the fundamental set of demand-supply equations given in (5.13).

In this section the supply and demand components of the Basic I-O model have been described and defined. Development of the two final demand sectors of the I-O model, personal consumption, and regional government expenditures, is deferred until Sections 5.5 and 5.6. In the following section, 5.4.2, the I-O accounting identity and the interregional income accounting system are compared. This comparison highlights the significant similarities between the two models.

5.4.2 The Basic Input-Output Accounting Identity

Throughout this discussion the Basic I-O model represented by equation (5.13) is referred to as the I-O accounting identity. Fei and Moses (Moses, 1955) have established that this I-O accounting identity is based on two equilibrium conditions:

1. The total demand for the output of each industry in each region is equal to the sum of the final demands for this output and the intermediate demand for this output in the region; and
2. The total demand in all regions for the output of an industry is equal to the supply of this output from all regions.

These equilibrium conditions are implied from the total demand-total supply equation of the income accounting system, equation (5.3). Furthermore, equation (5.13) which is a generalized form of equation (5.3) also implies that the Basic I-O model satisfies these equilibrium conditions.

The I-O model is now expressed in a slightly different form to demonstrate the equivalence of the interregional income accounting identity, equation (5.9), and the I-0 accounting identity, equation (5.13). First, subtract $\underline{\underline{T}}\ \hat{\underline{\underline{A}}}\ \underline{X}$ from both sides of (5.14) so that

(5.20a) $$[\hat{\underline{\underline{I}}} - \underline{\underline{T}}\ \hat{\underline{\underline{A}}}]\underline{X} = \underline{\underline{T}}[\underline{C} + \underline{G} + \hat{\underline{\underline{F}}}'\ \underline{Z}],$$

where $\hat{\underline{\underline{I}}}$ is a mn x mn identity matrix. Second, sum all variables in (5.20a) over commodities i=1,...,n for each region which results in

(5.20b) $$\hat{\underline{\underline{II}}}[\hat{\underline{\underline{I}}} - \underline{\underline{T}}\ \hat{\underline{\underline{A}}}]\underline{X} = \hat{\underline{\underline{II}}}[\underline{\underline{T}}\ \underline{C} + \underline{G} + \hat{\underline{\underline{F}}}'\ \underline{Z}].$$

$\hat{\underline{\underline{II}}}$ is a m x nm block diagonal "summing matrix". Each block on the diagonal is a lxn unit row vector $\underline{q}^k = [1]$. The resulting m equations from the I-0 model in (5.20b) are identical to the income accounting identity summarized in equation (5.9).

The I-0 accounting identity, equation (5.13), represents the first mn rows of the interregional income accounting system presented in Figure 5.1. Both the interregional I-0 model and the interregional income accounting system are constructed from the same data, and both are consistent with the same constraints. The major advantage of the interregional I-0 model derives from its theoretical foundations which permit considerable generalization of this quantitative model of production and consumption. This is in contrast to the income accounting system which can not be generalized.[5]

In general, the Basic I-0 model, summarized in equation (5.13), can be solved to obtain the functional relationship between output, $\underline{X}$, and exogenous final demands, $\underline{\underline{T}}\ \underline{C}$, $\underline{\underline{T}}\ \underline{G}$, and $\underline{\underline{T}}\ \hat{\underline{\underline{F}}}'\ \underline{Z}$. This relationship is

(5.20c) $$\underline{X} = [\hat{\underline{\underline{I}}} - \underline{\underline{T}}\ \hat{\underline{\underline{A}}}]^{-1}\ \underline{\underline{T}}[\underline{C} + \underline{G} + \hat{\underline{\underline{F}}}'\ \underline{Z}],$$

where $\underline{\underline{I}}$ is a mn x mn identity matrix and $[\hat{\underline{\underline{I}}} - \underline{\underline{T}}\ \hat{\underline{\underline{A}}}]^{-1}$ is the Leontief inverse matrix. This I-0 model is employed to derive the total output, $\underline{X}$, required to satisfy regional government final demands, $\underline{\underline{T}}\ \underline{G}$, and the regional distribution of income generated in this production process. This analysis is conducted in Section 5.7.

5.4.3 Conclusion

This section concludes the presentation of the Basic interregional I-O model. This model has been developed with exogenous personal consumption, regional government, and other final demand sectors. In the following section, the personal consumption sector of the Basic model is endogenized. Many important features of the final demand sectors in the Basic model remain unchanged in the transition to an endogenous personal consumption I-O model. Specifically, the behavioral explanations of personal consumption and regional government expenditures are not changed.

5.5 The Keynesian-Leontief Input-Output Model

Throughout the preceding sections, the personal consumption sector was treated as an exogenous sector of the interregional I-O model. The significance of this assumption is apparent if the Basic I-O model is contrasted with the standard Keynesian macroeconomic model in which personal consumption is endogenous. From the discussion of the interregional income accounting system, in Section 5.3, it is apparent that any increase in output will generate an increase in household income in the form of wage value-added. Assuming that the personal consumption component of final demand is positively related to household income, the increase in output will indirectly generate an increase in this component of final demand. This increased final demand will generate further increases in output. In the Basic I-O model, these changes in the personal consumption component of final demand are not considered. Therefore, the increases in total output and household income are less than the increases generated by treating personal consumption endogenously.

In this section, an I-0 model, the Keynesian-Leontief I-0 model, with an endogenous personal consumption sector is developed. In this development, the personal consumption sector is treated as a production sector.[6] A behavioral model of personal consumption is presented in Section 5.5.1. This behavioral model provides a format for treating the personal consumption sector as an endogenous sector in the interregional I-0 model. This I-0 model is presented in Section 5.5.2. Finally, the relationship between the interregional income accounting system and the Keynesian-Leontief I-0 model is discussed in Section 5.5.3. In addition, the relevance of this I-0 model to the analysis of federal grants is discussed in Section 5.5.3.

5.5.1 A Behavioral Model of Personal Consumption Final Demand

A behavioral model of personal consumption is presented in this section. The personal consumption vector, $\underline{C}$, specified in equation (5.15d),

$$(5.15d) \qquad \underline{C} = \hat{\underline{\underline{c}}}\underline{N} = [\sum_{k=1}^{m} b_i^k \, \nu^k],$$

is the basis of this discussion.

Consider the b_i^k coefficients of the $\hat{\underline{\underline{c}}}$ matrix. These coefficients represent the marginal propensities of households in region k to consume commodities, i=1,...,n, and primary inputs. b_i^k coefficients are obtained from aggregate expenditure functions which are derived from the following constrained maximization problem. All consumers in province k have identical Cobb-Douglas utility functions of the form,

$$(5.21) \qquad U_c^k = \sum_{i=1}^{n+1} b_i^k \log c_i^k + b_v^k \log v_c^k$$

where

$$(5.22) \qquad \sum_{i=1}^{n+1} b_i^k + b_v^k = 1,$$

c_i^k, i=1,...,n, is the quantity of commodity i and i=n+1 is the quantity of primary labour inputs consumed directly by household, and v_c^k represents savings.[7]

Maximizing (5.22) for the ath consumer subject to his budget constraint,

$$(5.23) \qquad \nu_a^k = \sum_{i=1}^{n+1} P_i^k c_{ia}^k + v_{ca}^k ,$$

and solving the n+3 first order conditions for c_{ia}^k gives consumer a's demand for commodity i. Consumer expenditure on commodity i, i=1,...,n+1,

$$(5.24) \qquad P_i^k c_{ia}^k = b_i^k \nu_a^k ,$$

is a linear function of personal income, ν_a^k. Summing over all consumers, a=1,...,ℓ, in region k, the aggregate expenditure function for commodity i in region k is,

$$(5.25) \qquad \sum_{a=1}^{\ell} P_i^k c_{ia}^k = b_i^k \sum_{a=1}^{\ell} \nu_a^k .$$

Alternatively, the aggregate expenditure function is described by,

$$(5.26) \qquad c_i^{*k} = b_i^k \nu^k ,$$

where c_i^{*k} is aggregate personal expenditure on commodity i in region k.

The b_i^k coefficients are constant for any level of personal income; thus, they are average and marginal propensities to consume out of personal income. This property of the b_i^k coefficients facilitates consideration of these coefficients as input-output coefficients in the I-0 model. In the following section, the consumption sector is treated as a production sector and incorporated in the inter-industry flow matrix.

5.5.2 Input-Output and Endogenous Personal Consumption

Having developed the behavioral model of personal consumption, an I-0 model with an endogenous consumption sector, the Keynesian-Leontief I-0 model, is easily derived. The development of the Keynesian-Leontief I-0 model is presented in three parts; the personal disposable income equation, the single region Keynesian-Leontief I-0 model, and the inter-regional Keynesian-Leontief I-0 model.

Personal Income

Prior to the construction of the Keynesian-Leontief I-0 model, the personal income equations for this I-0 model must be explicitly developed. For ease of reference, consider only region k. Personal income in region k, ν^k, is the sum of four components:

1. wage value-added in producing industries,

$$\sum_{j=1}^{n} w_j^k = \sum_{j=1}^{n} a_{wj}^k x_j^k , \tag{5.27}$$

where a_{wj}^k is the labour input-output coefficient for industry i;

2. wage value-added consumed directly by households, w_c^k,

$$w_c^k = b_s^k \nu^k , \tag{5.28}$$

where b_s^k is the share of total consumption expenditure which is allocated for the direct purchases of labour; and

3. wage value-added in regional government final demand, w_G^k, and wage value-added in other final demand, w_F^k .

Thus, personal income, which is equal to wage income, in region k is

$$(5.29) \qquad \nu^k = \sum_{j=1}^{n} a_{wj}^k \, x_j^k + b_s^k \, \nu^k + w_G^k + w_F^k \, .$$

From equation (5.29), it is seen that wage income in region k corresponds to the "earnings from employment" row for region k in the interregional income accounting system summarized in Figure 5.1. This representation of personal disposable income is consistent with the arrangement of the intermediate and final demand sectors of the I-0 model. More importantly, this equation links the producing sectors, the regional government sector, and the other final demand sector on one hand, with the personal consumption sector on the other. This relationship is discussed in greater detail in the following section.

The Single Region Keynesian-Leontief Input-Output Model

Having defined personal income, the Keynesian-Leontief I-0 model for region k is presented. Forming this I-0 model from the Basic I-0 model is relatively straightforward. The transition from the Basic I-0 model to the Keynesian-Leontief I-0 model involves incorporating the consumption component of the final demand column vector, $\underline{c}^{*k}$, and the wage value-added row vector, $\underline{W}^{k'}$, in the inter-industry flow matrix, $\underline{\underline{A}}^k$.

For clarity, this process is described in detail. First, the fundamental demand-supply equations for region k, equation (5.13), and the personal income equation for region k, equation (5.29), are written as a system of n+1 equations. These equations, (5.30) and (5.31), form the foundations of the Keynesian-Leontief I-0 model and illustrate the basic relationships. This system of equations is

(5.30) $$x_i^k = \sum_{j=1}^{n} t_j^{kk} a_{ij}^k x_j^k + t_i^{kk} b_i^k \nu^k + t_i^k(g_i^k + f_i^k) + e_i^k, \quad i=1,\ldots,n,$$

(5.31) $$\nu^k = \sum_{j=1}^{n} a_{wj}^k x_j^k + b_s^k \nu^k + w_G^k + w_F^k .$$

The e_i^k term in equation (5.30) summarizes total exports by industry i in region k to all other regions. Total demand for commodity i, intermediate demand and final demand, in the I-0 model for region k should be expressed to exclude all imports from other regions. In equation (5.30), imports are excluded from these demand expressions when total domestic demand for commodity i in region k is multiplied by the trade coefficient t_i^{kk} .

Equations (5.30) and (5.31) are now expressed in more compact matrix vector notation. The I-0 accounting balance equation for region k emerges. The system of n+1 equations is represented as

(5.32) $$\underline{X}^k = \hat{\underline{\underline{T}}}^{kk} \underline{\underline{A}}^k \underline{X}^k + \hat{\underline{\underline{T}}}^{kk} \underline{c}^{*k} \nu^k + \hat{\underline{\underline{T}}}^{kk} [\underline{G}^k + \underline{F}^k] + \underline{E}^k$$

(5.33) $$\nu^k = \underline{W}^{k'} \underline{X}^k + b_s^k \nu^k + w_G^k + w_F^k ,$$

where $\underline{X}^k$ is a nx1 column vector of output produced in region k;

$\underline{G}^k$ and $\underline{F}^k$ represent nx1 column vectors of government final demands and other final demands for output in region k;

$\underline{W}^{k'}$ is a 1xn row vector of wage value-added input-output coefficients in region k, a_{wj}^k; and

$\underline{E}^k$ represents a nx1 column vector of exports from region k to all other regions.

Finally, if equations (5.32) and (5.33) are written in expanded matrix vector format, the structure of the Keynesian-Leontief I-0 model for region k is readily apparent. This model is the m(n+1) fundamental equations. The discussion of the interregional Keynesian-Leontief I-0 model will proceed by generalizing the single region I-0 model summarized in equation (5.36).

For analytical purposes, the Keynesian-Leontief I-0 model is divided into four components:

1. the inter-industry-personal consumption flow matrix, $\hat{\underline{\underline{D}}}_1$,
2. the trade coefficient matrix, $\tilde{\underline{\underline{T}}}$,
3. the exogenous final demand vectors, $\tilde{\underline{G}}$ and $\tilde{\underline{F}}$, and
4. the output and personal disposable income vector, $\tilde{\underline{\underline{X}}}$.

First, consider the inter-industry-personal consumption flow matrix, $\hat{\underline{\underline{D}}}_1$. An inter-industry-personal consumption flow matrix $\underline{\underline{D}}^k$, of order n+1, is defined for each region k, k=1,...,m. Arranging the m $\underline{\underline{D}}^k$ matrices as blocks along the diagonal of a larger matrix, the matrix $\hat{\underline{\underline{D}}}_1$ is formed. $\hat{\underline{\underline{D}}}_1$ is a m(n+1) x m(n+1) block diagonal matrix. Each block on the diagonal of $\hat{\underline{\underline{D}}}_1$ is a (n+1) x (n+1) regional inter-industry-personal consumption flow matrix, $\underline{\underline{D}}^k$. This $\hat{\underline{\underline{D}}}_1$ matrix of the Keynesian-Leontief I-0 model is analogous to the $\hat{\underline{\underline{A}}}$ matrix in the Basic I-0 model.

Second, consider the trade coefficient matrix. The trade coefficient matrix in the Keynesian-Leontief I-0 model, $\tilde{\underline{\underline{T}}} = [\hat{\tilde{\underline{\underline{T}}}}^{rk}]$, is a m(n+1) x m(n+1) matrix with m^2 sets of (n+1)x(n+1) diagonal matrices, $\hat{\tilde{\underline{\underline{T}}}}^{rk}$. Each $\hat{\tilde{\underline{\underline{T}}}}^{rk} = [t_i^{rk}]$ matrix has diagonal elements which represent the flow of commodity i from region r to region k.

The n+1th diagonal element in each $\hat{\tilde{\underline{\underline{T}}}}^{rk}$, matrix, t_{n+1}^{rk}, is a trade coefficient which represents the interregional flow of wage value-added. Assuming no interregional flow of wage value-added, the value of each trade coefficient, t_{n+1}^{rk}, is determined. These values are

(5.38a) $t^{rk}_{n+1} = 0,\ r \neq k$

and

(5.38b) $t^{rr}_{n+1} = 1,\ r = 1,\ldots,m$.

This assumption is consistent with the development of the single region Keynesian-Leontief I-O model in the preceding section.

Next, consider the exogenous final demand vectors, $\tilde{\underline{\underline{T}}}\ \tilde{\underline{G}}$ and $\tilde{\underline{\underline{T}}}\ \tilde{\underline{F}}$. $\tilde{\underline{G}}$ is a m(n+1) column vector of regional governments' demand for n commodities and labour. The arrangement of elements in $\tilde{\underline{G}}$, g^k_i, is similar to the arrangement of the government final demand vector in the single region Keynesian-Leontief I-O model which was summarized in equation (5.36). Thus, $\tilde{\underline{G}}$ contains m sets of regional government final demand values. Each set of n+1 elements corresponds to one regional government's demand for commodities, g^k_i, i=1,...,n, and labour, w^k_G. the n+1th element in each set represents wage value-added. This vector is schematically represented in Appendix A.

The vector representing other final demand, $\tilde{\underline{F}}$, is also a m(n+1) column vector. This vector describes the other final demand vector $\underline{F}$, which is now augmented to include the other final demand for labour. The arrangement of elements in $\tilde{\underline{F}}$, f^k_i, is similar to that of the augmented regional government final demand vector, $\tilde{\underline{G}}$.

As in the Basic I-O model, $\underline{F}$ is formed from two components:

1. the matrix of other final demand coefficients, $\hat{\tilde{\underline{\underline{F}}}}'$, and
2. the vector of other final demand values.

First, consider the coefficient matrix, $\hat{\tilde{\underline{\underline{F}}}}' = [\tilde{\underline{\underline{F}}}^{k'}]$. This matrix is a m(n+1) x mK block diagonal matrix. Each block on the diagonal, $\tilde{\underline{\underline{F}}}^{k'}$ =

$[f^{k'}_{Fi}]$ is a (n+1) x K matrix, of other final demand coefficients which allocate other final demand expenditures to industries. The first n coefficients in each column of $\tilde{\underline{\underline{F}}}^{k'}$, $f^{k'}_{Fi}$, i=1,...,n, are commodity coefficients. The n+1th coefficient in each column of $\tilde{\underline{\underline{F}}}^{k'}$, $\tilde{w}^{k}_{F}$, is a wage value-added coefficient.

The second component of $\tilde{\underline{F}}$, the vector of other final demand values, $\underline{Z}$, is not changed in the Keynesian-Leontief I-O model. This vector is described in Section 5.4.1.

Finally, consider the output and personal income vector, $\tilde{\underline{X}}$. $\tilde{\underline{X}}$ is a m(n+1) column vector of m sets of output, x^{k}_{i}, i=1,...,n, and personal income, ν^{k}. Each set of (n+1) elements corresponds to the output and personal income in one region. The n+1th element in each set is the value of regional personal income. A schematic representation of the vector $\tilde{\underline{X}}$ is presented in Appendix A.

Having defined the component matrices and vectors of the interregional Keynesian-Leontief I-O model, the I-O accounting balance equation can be formed. The accounting balance equation for the interregional I-O model with an endogenous consumption sector is

$$\text{(5.39)} \qquad \tilde{\underline{X}} = \tilde{\underline{\underline{T}}}\,\hat{\underline{\underline{D}}}_1\,\tilde{\underline{X}} + \tilde{\underline{\underline{T}}}\,\tilde{\underline{G}} + \tilde{\underline{\underline{T}}}\,\hat{\tilde{\underline{\underline{F}}}}'\,\underline{Z}\,.$$

Equation (5.39) is a generalization of the single region I-O model presented in equation (5.37). In the generalized model, no export vector is specifically stated. Each region's exports are included in the intermediate demand matrix, $\tilde{\underline{\underline{T}}}\,\hat{\underline{\underline{D}}}_1$, and the final demand vectors, $\tilde{\underline{\underline{T}}}\,\tilde{\underline{G}}$ and $\tilde{\underline{\underline{T}}}\,\hat{\tilde{\underline{\underline{F}}}}'\,\underline{Z}$.

The significance of the Keynesian-Leontief I-O model, for the analysis of federal grants and the relationships between this model and the interregional income accounting system, is discussed in the following section.

5.5.3 The Keynesian-Leontief Input-Output Accounting Identity

The Keynesian-Leontief I-O model summarized in equation (5.39) is a subset of the interregional income accounting system presented in Section 5.3. This I-O model is formed from two components of the income accounting system. These are, the mn commodity demand-supply equations, generalized from equation (5.3) of Section 5.3 which form the product side of the model. These equations represent the mn "producing industries" rows of Figure 5.1. Second, the m "income from employment" rows of the income accounting table, Figure 5.1, form the m personal income equations. Thus, the I-O model in equation (5.39) is a rearrangement of the data compiled in the interregional income accounting system.

This I-O model, however, does more than simply restate the information contained in the interregional income accounting system. The I-O model is more general than the income accounting system and provides an analytical framework in which interregional production and income creation effects of changes in exogenous final demands can be analyzed. For example, employing the I-O model, it is possible to calculate the changes in the value of outputs and personal income in each region in response to changes in exogenous final demand in any region. An $\underline{\tilde{X}}$ vector which is consistent with exogenous final demands $\underline{\tilde{G}}$ and $\underline{Z}$ is obtained by solving equation (5.39) for $\underline{\tilde{X}}$.

$$(5.40) \qquad \tilde{\underline{X}} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\,\hat{\underline{\underline{D}}}_1]^{-1}\,[\tilde{\underline{\underline{T}}}\,\tilde{\underline{G}} + \tilde{\underline{\underline{T}}}\,\hat{\tilde{\underline{\underline{F}}}}'\,\underline{Z}]$$

This result will be used in Section 5.7 to analyze changes in regional government final demands. This permits analysis of the regional income distribution effects of federal grants to regional governments. The effects of these grants are examined by considering their impact on regional government final demands.

5.5.4 Conclusion

In this section, an I-O model with an endogenous consumption sector has been presented. This I-O model, the Keynesian-Leontief I-O model, is more realistic than the Basic I-O model presented in Section 5.4. The increased realism of this model results from closure of the system whereby production leads to factor earnings, which stimulate increased expenditure for personal consumption. These increases in expenditure for personal consumption, in turn, create additional production requirements to supply the additional goods and to generate the increased income flows. This model will be used, in Section 5.7, to analyze the production and employment income generated by an increase in regional government final demand.

In the following section, the regional government final demand vector is discussed in detail.

5.6 The Regional Government Final Demand Vector

In this section, the behavioral model of regional government expenditure which was developed in Chapter 4 is incorporated into the regional government final demand sector of the I-O models. The Basic and Keynesian-Leontief I-O models, developed in Sections 5.4 and 5.5

respectively, indicate that changes in regional government expenditure induced by changes in federal grants will affect the composition and level of industrial output and employment income in each region. In order to efficiently analyze these grant induced changes in regional government expenditure, the five fiscal response coefficients and federal grant parameters which were derived in Chapter 4 are presented in matrix-vector format. The five fiscal response coefficients which are included in this specification of regional government final demand are:

1. the unconditional grant coefficient, η_K^k ,
2. the conditional non-matching grant coefficient, γ_K^k ,
3. the open-ended matching grant coefficient, $\gamma_{KI}^{k'}$,
4. the closed-matching grant--matching ratio coefficient, $\eta_{PKI}^{k'}$, and
5. the closed-ended matching grant--grant limit coefficient, $\eta_{KI}^{k'}$.

The changes in regional government expenditure which are depicted in these coefficients are summarized in the mf x 1 column vector $d(\underline{E})$. This vector is defined in equation (5.41a).

$$(5.41a) \qquad d(\underline{E}) = \hat{\underline{\underline{H}}}_{GU}\ \underline{\bar{\Gamma}}_U + \widehat{H'}_{GN}\ \underline{\bar{\Gamma}}_N + \widehat{\underline{\underline{H}}'}_{PO}\ \underline{P}_O + \widehat{\underline{\underline{H}}'}_{GC}\ \underline{\bar{\Gamma}}_C + \widehat{\underline{\underline{H}}'}_{PC}\ \underline{P}_C$$

Elements of $d(\underline{E})$ represent changes in regional government expenditure on each of f programs. The increased demand for goods and services generated by these increases in government expenditure is described in equation (5.41b).

$$(5.41b) \qquad d(\underline{G}) = \hat{\underline{\underline{G}}}\ d(\underline{E})$$

d(G) is a mnx1 column vector of changes in regional government final demand induced by a marginal change in each grant parameter. This column vector represents the change in each element of regional government final demand, G, described in Section 4.4.1. In equation (5.41b), $\hat{G} = [g^k_{iK}]$, a mnxmf block diagonal matrix, summarizes the per dollar final demand coefficients for service K, K=1,...,f, by regional government k, k=1, ...,m. Each block along the main diagonal of $\hat{G}$, G^k is nxf matrix. This matrix is represented schematically in Appendix A.

$\hat{H}_{GU} = [\eta^k_I]$ is a mfxm block diagonal matrix indicating the allocation of marginal increases in unconditional grants to programs by each regional government. Each block on the diagonal is a fx1 column vector of η^k_I coefficients representing one regional government. The $\hat{H}_{GU}$ matrix is presented schematically in Appendix A.

The marginal increases in unconditional grants are represented in the m x 1 column vector $\bar{\Gamma}_U = [d\Gamma^k]$.

Similarly, $\hat{H}'_{GN} = [\gamma^k_K]$ and $\hat{H}'_{GC} = [\eta^{k'}_{KI}]$ are mf x mf block diagonal matrices representing the allocation of marginal changes in conditional non-matching grants and of marginal changes in the grant limit of closed-ended matching grants. Each block on the diagonal of $\hat{H}'_{GN}$ is a f x f matrix of γ^k_K coefficients corresponding to one regional government. In an analogous fashion, each block on the diagonal of $\hat{H}'_{GC}$ is a f x f matrix of η^k_{KI} coefficients. Each of these matrices is represented schematically in Appendix A.

The marginal changes in conditional non-matching grants and in the grant limits of closed-ended matching grants are represented in the vectors $\bar{\Gamma}_N = [d\ \bar{\Gamma}^k_K]$ and $\bar{\Gamma}_C = [d\bar{\Gamma}^k_{KC}]$ respectively. Both of these mf x 1 column vectors are partitioned into m individual fxl sub-vectors which correspond to a regional government.

Changes in expenditure induced by marginal changes in the matching ratio of open- and closed-ended matching grants are summarized in the $\hat{\underline{\underline{H}}}'_{PO} = [\gamma^{k'}_{KI}]$ and $\hat{\underline{\underline{H}}}'_{PC} = [\eta^{k'}_{PKI}]$ matrices respectively. Both matrices are mf x mf block diagonal matrices in which each block on the diagonal is a f x f matrix of regional government expenditure responses. These matrices of regional government expenditure responses are presented schematically in Appendix A.

Marginal changes in the matching ratios of open- and closed-ended matching grants are described in the $\underline{P}_o = [d\omega^k_I]$ and $\underline{P}_c = [d\omega^k_I]$ vectors respectively. $\underline{P}_o$ and $\underline{P}_c$ are mf x 1 column vectors which are partitioned into m individual fxl sub-vectors which correspond to each regional government.

This matrix-vector summary of the behavioral model of regional government expenditure provides a succinct format for analyzing the effects of federal grants on regional government expenditure. This specification of changes in regional government final demand is the basis of the subsequent analysis of the interregional production and employment-income generated by federal grants to regional governments. These interregional production and employment income effects of federal grants are discussed in the following section.

5.7 Interregional Production and Employment Income Effects of Federal Grants

The behavioral model of regional government expenditure, developed in Chapter 4 and specified in matrix-vector format in Section 5.6, provides a link between federal grants and the demand for industrial output. Changes in regional government final demand generate additional production activity which consequently increase employment income in both the recipient region and the regions with which it trades. Employing the I-O models developed in Sections 5.4 and 5.5, these interregional production and employment income effects of federal grants are derived. The short-run nature of these production and income effects must be emphasized. In all cases, the level of investment is assumed to remain constant.

For purposes of exposition, this analysis is presented in three parts:

1. the production effects,
2. the employment income effects by industry, and
3. the employment income effects by region.

These three effects are interrelated. The relationship between the production effects, and the employment income effects in each industry and region are summarized, for a single region, by equation (5.26). The production effects represent the value of output which is generated in each industry of each region from an exogenous increase in final demand, e.g., regional government expenditure. In producing this increased output, employment is increased and, thus, employment income is generated. The increase in output is translated into an increase in income in each industry and region through the wage value-added component of each industry. Thus, for a given production effect, a specific increase in the employment income in each industry is determined in equation (5.27). This increase in employment income in each industry is the employment income effect by industry. Similarly, the value of the increase in employment income in a region arises from the value of the employment income effect by industry. Specifically, the employment income effect by region is the sum of the employment income effects in each industry and primary input sector in the region. These production and employment income effects are interregional in nature. Each effect is now discussed.

5.7.1 Interregional Production Effects

On the basis of equations (5.20c) and (5.40) which describe the aggregate effects of personal consumption, regional government, and other final demands upon regional output, the interregional production effects of federal grants to regional governments are discussed. The output generated in the production sectors of regional economies is considered to occur in two phases:

1. direct plus indirect output (DI), which is required to satisfy final and intermediate demands, and
2. direct plus indirect plus induced output (DII), where induced output is the output required to satisfy demands induced by the endogenous personal consumption sector.

Each production effect is now discussed. In this discussion, each federal grant is considered independently of other grants.

Direct Plus Indirect Production Effects

First consider the DI production effects of an increase in a federal grant to a regional government. These production effects are decomposed into two components:

1. the direct effect which describes the gross output required to meet a regional government's demand for final goods and services; and

2. the indirect effect which refers to the gross output required to support the production activities necessary for producing these final goods and services.

The DI production effects of regional government final demands are defined for an I-0 system with an exogenous personal consumption sector. Thus, the DI production effect of a federal grant to regional government k is calculated by applying the Basic I-0 model to the increase in k's final demand which is induced by the increased grant. Equation (5.20c) describes the general form of the DI production effects. Assuming no change in personal consumption or other final demands, the DI production effects from an increased federal grant are summarized in the mnxl column vector ${}_1\underline{X} = [dx_i^k]$ in equation (5.42),

$$(5.42) \qquad {}_1\underline{X} = [\hat{\underline{\underline{I}}} - \underline{\underline{T}}\,\hat{\underline{\underline{A}}}]^{-1}\,\underline{\underline{T}}\,\hat{\underline{\underline{G}}}\cdot d(\underline{E}) \ .$$

An example will illustrate the nature of the DI production effects from increased federal grants. Consider the DI production effect of a one dollar increase in the unconditional grant to regional government k. As all other grants remain unchanged, all grant vectors in equation (5.41a) except the unconditional grant vector, $\underline{\bar{\Gamma}}_u$, are zero vectors. The unconditional grant vector, in this case, has all elements set equal to zero except the k^{th} element which is unity. This version of the unconditional grant vector is represented as $\underline{\bar{\Gamma}}_u^k$. Thus, the change in government expenditure specified in equation (5.41a) is

$$(5.43a) \qquad d(\underline{E}) = \hat{\underline{\underline{H}}}_{Gu}\,\underline{\bar{\Gamma}}_u^k \ .$$

Substituting this form of d($\underline{E}$) into equation (5.42), the DI production effect of a one dollar increase in the unconditional grant to regional government k is described in equation (5.43b)

$$(5.43b) \qquad {}_1\underline{X}^k_u = [\hat{\underline{\underline{I}}} - \underline{\underline{T}}\,\hat{\underline{\underline{A}}}]^{-1}\,\underline{\underline{T}}\,\hat{\underline{\underline{G}}}\,\hat{\underline{\underline{H}}}^k_{Gu}\,\underline{\bar{\Gamma}}^k_u\,.$$

Here, ${}_1\underline{X}^k_u = [dx^k_i]$ is a mnxl column vector of DI production effects.

The DI production effects, for regional government k, of

1. a one dollar increase in a conditional non-matching grant for program K;
2. a one dollar increase in the grant limit of a close-ended matching grant for program K; or
3. a reduction in the matching ratio of an open- or closed-ended matching grant for program K[8]

are obtained by setting the appropriate elements of the grant vectors in equation (5.41a) equal to zero or unity.[9] The resulting d($\underline{E}$) vector is substituted into equation (5.42a) to form the DI production effects. These production effects for a one dollar increase in each type of federal grant to regional government k are presented in column 1 of Table 5.1.

This DI production effect describes the impact of an increased federal grant on the gross output of each region. However, it is inadequate as a measure of increased economic activity in each region since the personal consumption sector is treated exogenously. The DI production effect understates the impact of federal grants on each regional economy to the extent that consumption final demand increases as gross output increases. In the next section, a production effect is discussed in which personal consumption is treated endogenously.

TABLE 5.1

INTERREGIONAL PRODUCTION EFFECTS OF A ONE DOLLAR INCREASE IN FEDERAL GRANTS TO REGIONAL GOVERNMENT k

Type of Grant	(1) Direct Plus Indirect Production Effects	(2) Direct Plus Indirect Plus Induced Production Effects*
(1) Unconditional grant to government k	$_1X^k_u = [\hat{I} - T\hat{A}]^{-1} T\hat{G}\hat{H}_{Gu}\bar{\Gamma}^k_u$	$\tilde{X}^k_u = [\hat{I} - \tilde{T}D_1]^{-1}\tilde{T}\hat{\hat{G}}\hat{H}_{Gu}\bar{\Gamma}^k_u$
(2) Conditional non-matching grant for program K in government k, case 1 and case 2	$_1X^k_{NK} = [\hat{I} - T\hat{A}]^{-1} T\hat{G}\widehat{H}_{GN}\bar{\Gamma}^k_{NK}$	$\tilde{X}^k_{NK} = [\hat{I} - \tilde{T}D_1]^{-1}\tilde{T}\hat{\hat{G}}\widehat{H}_{GN}\bar{\Gamma}^k_{NK}$
(3) Open-ended matching grant for program K in government k	$_1X^k_{OK} = [\hat{I} - T\hat{A}]^{-1} T\hat{G}\widehat{H}_{PO}P^k_{OK}$	$\tilde{X}^k_{OK} = [\hat{I} - \tilde{T}D_1]^{-1}\tilde{T}\hat{\hat{G}}\widehat{H}_{PO}P^k_{OK}$
(4) Close-ended matching grant for program K in government k; case 1 or case 2 ($d\omega^k_K$)	$_1X^k_{CK} = [\hat{I} - T\hat{A}]^{-1} T\hat{G}\widehat{H}_{PC}P^k_{CK}$	$\tilde{X}^k_{CK} = [\hat{I} - \tilde{T}D_1]^{-1}\tilde{T}\hat{\hat{G}}\widehat{H}_{PC}P^k_{CK}$
(5) Close-ended matching grant for program K in government k; case 3 or case 2 ($d\bar{\Gamma}^k_{KC}$)	$_1X^k_{CK} = [\hat{I} - T\hat{A}]^{-1} T\hat{G}\widehat{H}_{GC}\bar{\Gamma}^k_{CK}$	$\tilde{X}^k_{CK} = [\hat{I} - \tilde{T}D_1]^{-1}\tilde{T}\hat{\hat{G}}\widehat{H}_{GC}\bar{\Gamma}^k_{CK}$

* Includes both production and income effects

Direct Plus Indirect Plus Induced Production Effects

The previous discussion of federal grant production effects has treated personal consumption as exogenous. This shortcoming of the analysis is corrected here with the discussion of DII production effects of federal grants. This production effect is decomposed into three components:

1. the direct output effect,
2. the indirect output effect, and
3. the induced output effect which describes the outputs required to meet the change in personal consumption final demand induced by changes in production and income.

Thus, the DII production effect is obtained by applying the solution to the Keynesian-Leontief I-O model, equation (5.40), to changes in final demand. Here, the change in final demand is the change in regional government k's final demand which is induced by an increase in federal grants. The general form of this production effect is

$$(5.44a) \qquad \underline{\tilde{X}} = [\underline{\underline{\hat{I}}} - \underline{\underline{\tilde{T}}}\ \underline{\underline{D}}_1]^{-1}\ \underline{\underline{\tilde{T}}}\ \underline{\underline{\hat{\tilde{G}}}} \cdot d(\underline{E}) \ .$$

$\underline{\tilde{X}}$ is a m(n+1)x1 column vector of changes in output, dx_i^k, and personal income, $d\nu^k$, which are arranged by production sector and region. Every (n+1)th element of $\underline{\tilde{X}}$ is a personal income term. Thus, in discussing the DII production effects, every (n+1)th element of $\underline{\tilde{X}}$ is ignored.

For purposes of illustration, consider the DII production effects of a one dollar increase in the unconditional federal grant to regional government k. Assuming all other grants are unchanged, the change in expenditure by regional government k is described by equation (5.42b).

Substituting this vector for d($\underline{E}$) in equation (5.44a) the DII production effect of this grant is

$$(5.44b) \qquad \tilde{\underline{X}}_u^k = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}} \; \underline{\underline{D}}_1]^{-1} \; \tilde{\underline{\underline{T}}} \; \hat{\tilde{\underline{\underline{G}}}} \; \underline{\underline{H}}_{Gu} \; \bar{\underline{\Gamma}}_u^k \; .$$

In addition, the DII production effects of all other federal grants considered individually can be obtained by substituting the appropriate expenditure response matrix and grant vector for $\hat{\underline{\underline{H}}}_{Gu}$ and $\bar{\underline{\Gamma}}_u^k$ in (5.44b). The equations describing these grants are presented in column 2 of Table 5.1.

The DI and DII production effects describe the economic consequences of federal grants to regional governments. Within this set of production effects, the DII production effects which are derived from the Keynesian-Leontief I-O model more accurately describe the economic consequences of federal grants than does the DI production effects derived from the Basic I-O model. The explanation for this increased accuracy in describing production effects is the inclusion of personal consumption as an endogenous variable in the Keynesian-Leontief model. In the following sub-section, the employment income effects which are induced by federal grants to regional governments are developed. These income effects are calculated at the individual industry level in each region. The production effects described in this sub-section provide the basis of these income effects.

5.7.2 Employment Income Effects by Industry

The increase in output which is induced by federal grants and discussed in the previous sub-section will generate increased income for labour employed in each production sector and regional government sector of the economy. This income which accrues to labour is referred to as employment income and represents wage value-added. In this section, the interregional employment income effects in each industry which are induced by increased federal grants to regional governments are described. For analytical purposes, two employment income effects are developed at the individual industry level:

1. the direct plus indirect income effect by industry (DI_i) which is the wage value-added component in the direct plus indirect output generated by changes in federal grants; and
2. the direct plus indirect plus induced income effect in each industry (DII_i) which is the wage value-added component in the direct plus indirect plus induced output generated by changes in federal grants.

Within the I-0 framework, each of these income effects is described by a system of equations which summarize the wage value-added portion of total output in each industry of the m regional economies. This system of equations is presented in matrix-vector notation, in very general terms, in equation (5.45a),

$$(5.45a) \qquad \underline{Y}^{+} = \hat{\underline{\underline{V}}}^{+}_{X} \, \underline{X} \, ,$$

where $\underline{Y}^{+}$ is a mn x 1 column vector of employment income, y_i^k, i=1,...,n, k=1,...,m, accruing to labour employed in each industry in each region;

$\hat{\underline{\underline{V}}}^{+}_{X}$ is a mn x mn diagonal matrix of wage value-added coefficients, a_{wi}^k, in each industry in each region; and

$\underline{X}$ is a mn x 1 column vector of total output x_i^k in each industry.

Each element of $\underline{Y}^{+}$ is one element on the right-hand side of equation (5.27).

This relationship is stated in equation (5.45b),

(5.45b) $$y_i^k = a_{wi}^k \; x_i^k \; .$$

This definition of employment income in each industry is now employed to describe the two employment income effects of changes in federal grants. In this discussion, the effects of a change in each federal grant is described independently of the effect of a change in any other grant.

The Direct Plus Indirect Employment Income Effects by Industry

First, consider the DI_i employment income effects of federal grants to regional government. This income effect is composed of two components:

1. the direct employment income effect by industry which is the wage value-added component of the produced inputs used directly by the regional government; and
2. the indirect employment income effect by industry which is the wage value-added included in the output produced to satisfy the indirect input requirements of regional government final demands.

The DI_i employment income effects are calculated on the assumption that personal consumption is exogenously determined. Thus, the Basic I-O model is employed in calculating these income effects. The general definition of DI_i employment income is derived from equation (5.45a). Here, the vector of DI production effects, $_1\underline{X}$, from equation (5.42) is substituted for $\underline{X}$ in equation (5.45a). This definition is presented in equation (5.46a).

$$(5.46a) \qquad {}_1\underline{Y}^{+} = \hat{\underline{\underline{V}}}_X^{+} \, {}_1\underline{X} = \hat{\underline{\underline{V}}}_X^{+} \, [\hat{\underline{\underline{I}}} - \underline{\underline{T}} \, \hat{\underline{\underline{A}}}]^{-1} \, \underline{\underline{T}} \, \hat{\underline{\underline{G}}} \cdot d(\underline{E})$$

This formulation of DI_i employment income is very general. To illustrate the calculation of the DI_i employment income effect for a specific federal grant, consider a one dollar increase in the unconditional grant to regional government k. The change in regional government final demand which is generated by this increased grant is summarized in equation (5.42b). Substituting this form of d($\underline{E}$) into equation (5.46a) the DI_i employment income effect by industry for one dollar increase in the unconditional grant to regional government k is obtained. These income effects are summarized in equation (5.47).

$$(5.47) \qquad {}_1\underline{Y}_u^{+k} = \hat{\underline{\underline{V}}}_X^{+} \, {}_1\underline{X}_u^{k} = \hat{\underline{\underline{V}}}_X^{+} \, [\hat{\underline{\underline{I}}} - \underline{\underline{T}} \, \hat{\underline{\underline{A}}}]^{-1} \, \underline{\underline{T}} \, \hat{\underline{\underline{G}}} \, \hat{\underline{\underline{H}}}_{Gu} \, \bar{\underline{\Gamma}}_u^{k}$$

Here, ${}_1\underline{Y}_u^{+} = [d_1 y_i^k]$ is a mn x 1 column vector of changes in direct plus indirect employment income in each industry of each region.

The DI_i employment income effects of a one dollar change in the other three federal grants are calculated in a similar fashion. Appropriate elements of the grant vectors in equation (5.41a) are set equal to unity or zero. The resulting d($\underline{E}$) vector is then substituted into equation (5.46) to obtain the mn x 1 column vector of DI_i employment income effects. These DI_i employment income effects for a one dollar increase in each type of federal grant to regional government k are presented in column 1 of Table 5.2.

In this sub-section, the computation of DI_i income effects has been discussed. These income effects are computed using a model which treats personal consumption as an exogenous final demand. Thus, the DI_i income effect understates the income which actually accrues to labour

TABLE 5.2

INTERREGIONAL EMPLOYMENT INCOME EFFECTS, BY INDUSTRY, OF A ONE DOLLAR INCREASE IN FEDERAL GRANTS TO REGIONAL GOVERNMENT k

Type of Grant	(1) Direct Plus Indirect Income Effect	(2) Direct Plus Indirect Plus Induced Income Effects
(1) Unconditional grant to government k	${}_1\underline{Y}^{+k}_{u} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{u}$	${}_2\underline{Y}^{+k}_{u} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{u}$
(2) Conditional non-matching grant for program K in government k, case 1 and case 2	${}_1\underline{Y}^{+k}_{NK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_1\underline{X}^{k}_{NK}$	${}_2\underline{Y}^{+k}_{NK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{NK}$
(3) Open-ended matching grant for program K in government k	${}_1\underline{Y}^{+k}_{OK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_1\underline{X}^{k}_{OK}$	${}_2\underline{Y}^{+k}_{OK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{NK}$
(4) Closed-ended matching grant for program K in government k, case 1 or case 2 ($d\omega^{k}_{K}$)	${}_1\underline{Y}^{+k}_{CK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_1\underline{X}^{k}_{CK}$	${}_2\underline{Y}^{+k}_{CK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{CK}$
(5) Closed-ended matching grant for program K in government k, case 3 or case 2 ($d\Gamma^{k}_{KC}$)	${}_1\underline{Y}^{+k}_{CK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_1\underline{X}^{k}_{CK}$	${}_2\underline{Y}^{+k}_{CK} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^{k}_{CK}$

employed in each industry. This deficiency is corrected in the calculation of DII_i employment income which is discussed in the following sub-section.

Direct Plus Indirect Plus Induced Employment Income Effects by Industry

Second, consider the DII_i employment income effects of increased federal grants. This income effect is formed from three elements:

1. the direct employment income effect by industry,
2. the indirect employment income effect by industry, and
3. the induced employment income effect by industry.

The direct and indirect employment income effects by industry are discussed in the preceding sub-section. The induced employment income component of the DII_i income effect represents the additional income which accrues to labour as a result of an endogenous increase in personal consumption. Here, the increase in personal consumption is a direct result of the increased income which is generated from a federal grant. Thus, the Keynesian-Leontief I-O model is employed in deriving this income effect.

As in the case of the DI_i employment income effects, the DII_i employment income effect is derived from equation (5.45a). In deriving the DII_i employment income effects from equation (5.45a), a mn x 1 column vector of DII production effects, ${}_2\underline{X}$, is formed from the m(n+1) x 1 column vector of production and disposable income effects, $\underline{\tilde{X}}$. ${}_2\underline{X}$ is obtained from $\underline{\tilde{X}}$ by eliminating the personal disposable income terms, e.g., every (n+1) element, which are contained in $\underline{\tilde{X}}$. Substituting the vector of DII production effects, ${}_2\underline{X}$, for $\underline{X}$ in equation (5.45a), the general form of the DII_i employment income effect induced by federal grants is obtained. This income effect is presented in equation (5.48a),

$$(5.48a) \qquad {}_2\underline{Y}^{+} = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}$$

where ${}_2\underline{Y}^{+} = [d_2 y_i^k]$ is a mn x 1 column vector of changes in direct plus indirect plus induced employment income in each industry of each region.

The DII_i employment income induced by a specific change in a federal grant to a regional government is calculated using equation (5.48a). This procedure is similar to the calculation of the DI_i income effects discussed in the two preceding sections. A regional government expenditure vector, $d(\underline{E})$, which is specific to the grant being analyzed is formed from equation (5.41a). This specific regional government expenditure equation is then substituted into equation (5.40) and the corresponding ${}_2\underline{X}$ vector of DII production effects is formed. Substituting this new ${}_2\underline{X}$ vector for $\underline{X}$ in equation (5.48a), the DII_i employment income effects in each industry which are specific to one federal grant are derived. For example, the DII_i employment income effects of a one dollar increase in the federal unconditional grant to regional government k is obtained by eliminating every (n+1)th element in $\tilde{\underline{X}}^k_u$ to form a mn x 1 column vector ${}_2\underline{X}_u$ and substituting this vector for ${}_2\underline{X}$ in equation (5.48a). This income effect is defined in equation (5.48b),

$$(5.48b) \qquad {}_2\underline{Y}^{+k}_u = \hat{\underline{\underline{V}}}^{+}_{X}\ {}_2\underline{X}^k_u$$

where ${}_2\underline{Y}^{+k}_u = [d_2 y^k_{iu}]$ is a mn x 1 column vector of DII_i employment income effects induced by a one dollar increase in the federal unconditional grant to regional government k.

The DII_i employment income effects of a one dollar increase in each of the three other federal grants are calculated in a method similar to that described by equation (5.48b). These income effects for a one dollar increase in the federal grant to regional government k are presented in column 2 of Table 5.2.

In this section, the employment income which accrues in each industry in each region has been discussed. This income is generated initially by an increase in one federal grant to a regional government. These income effects provide information on the impact of federal grants on the interregional and inter-industry distribution of employment income. In the following section, the total regional employment income effects of federal grants are discussed. These regional income effects include wage value-added in production as well as wage value-added in regional government final demand.

5.7.3 Employment Income Effects by Region

The increase in employment income in each industry is only part of the employment income accruing in a region as federal grants are increased. In addition to the employment income earned in the production sectors of the economy, income also accrues to labour services in the final demand sectors. Thus, DI_i and DII_i employment income effects by industry, presented in Section 5.7.2., understate the total employment income accruing in a region. In this section, the total interregional employment income effects, by region, of increases in regional government expenditure are presented. The increase in regional government expenditure is induced by changes in federal grants to regional governments. For analytical purposes, three employment income effects by region are developed:

1. the initial income effect which is wage value-added in the provision of regional government services;
2. the initial plus direct plus indirect income effect (IDI) which is wage value-added in the provision of regional government services and in the provision of the direct plus indirect output induced by this expenditure; and
3. the initial plus direct plus induced income effect (IDII) which is wage value-added in the provision of regional government services and in the provision of the direct plus indirect plus induced output generated by the increased expenditure.

Within the I-0 framework, each of these income effects is described by a system of equations which defines total employment income in each region. This system is presented for region k in equation (5.29) and is summarized for all regions in matrix vector notation in equation (5.49),

$$(5.49) \qquad \underline{Y} = \hat{\underline{\underline{V}}}_X \underline{X} + \hat{\underline{\underline{V}}}_N \underline{N} + \hat{\underline{\underline{V}}}_G \underline{E} + \hat{\underline{\underline{V}}}_Z \underline{Z} .$$

Here, $\underline{Y} = [y^k]$ is a mx1 column vector of total employment income in each region. $\hat{\underline{\underline{V}}}_X = [a^k_{wi}]$ is a mxmn block diagonal matrix where each block on the main diagonal is a 1xn row vector of wage value-added coefficients for a region which are arranged by I-0 sector. $\hat{\underline{\underline{V}}}_N = [w^k_c]$, is a diagonal matrix of wage value-added coefficients in consumption final demand expenditure. $\hat{\underline{\underline{V}}}_G = [w^k_f]$ is a mxmf block diagonal matrix. Each block on the diagonal of this matrix is a 1xf row vector of wage value-added coefficients for each of f services provided by a regional government. Finally, $\hat{\underline{\underline{V}}}_Z = [w^k_J]$ is a mxmK block diagonal matrix of other final demand wage value-added coefficients arranged by other final demand categories. Each block on the diagonal of $\hat{\underline{\underline{V}}}_Z$ is a 1xK row vector. Each of these wage value-added matrices is presented schematically in Appendix A.

This definition of total employment income is now employed to describe the three employment income effects of changes in federal grants. In this discussion the effects of a change in each federal grant are described independently of the effects of a change in any other grant.

Initial Employment Income Effects by Region

The initial employment income effect of an increased federal grant is apparent in the increased regional government wage bill of the program for which supply is increased. The wage bill per dollar of regional government k's increased final demand for program K is the wage value-added coefficient, w^k_{GK}, of the value-added matrix $\hat{\underline{\underline{V}}}_G$. Thus, the general form of the initial employment income effect of a one dollar increase in a federal grant is described in equation (5.49a),

$$(5.49a) \qquad {}_1\underline{Y} = \hat{\underline{\underline{V}}}_G \cdot d(\underline{E}) \ .$$

Elements of ${}_1\underline{Y}$, d_1y^k, represent the change in initial employment income in each region.

To illustrate this income effect for a change in a specific federal grant, consider a one dollar increase in the unconditional grant to regional government k. Assuming all other grants remain unchanged, the initial income of this grant is derived by substituting equation (5.43a) for d($\underline{E}$) in equation (5.49a). Thus, the initial income effect is

$$(5.49b) \qquad {}_{1}\underline{Y}^{k}_{u} = \hat{\underline{\underline{V}}}_{G}\,\hat{\underline{\underline{H}}}_{Gu}\,\underline{\bar{\Gamma}}^{k}_{u} .$$

A typical element of the ${}_{1}\underline{Y}^{k}_{u}$ vector is

$$(5.49c) \qquad d({}_{1}y^{k}) = \sum_{k=1}^{m} \sum_{I=1}^{f} w^{k}_{GI}\,\eta^{k}_{I}\,d\bar{\Gamma}^{k} .$$

The initial employment income effect of a one dollar increase in other federal grants is presented in column 1 of Table 5.3.

In this sub-section, the computation of the initial employment income effects of federal grants to regional governments has been discussed. In the following sub-section, the computation of the second type of employment income effect of federal grants, the initial plus direct plus indirect effect, is discussed.

Initial Plus Direct Plus Indirect Employment Income Effects

The second income effect discussed is the IDI employment income effect. This income effect is the total wage bill paid to labour as an input in additional production activities generated by increased regional government final demands. These production activities, however, exclude increases in production induced by an endogenous increase in personal consumption. Both intermediate and final demand must be considered in computing these income effects.

For purposes of exposition, the IDI income effect is decomposed into three components:

1. initial employment income,
2. direct employment income, and
3. indirect employment income.

The initial employment income effect has been discussed in the previous sub-section.

TABLE 5.3

INTERREGIONAL EMPLOYMENT INCOME EFFECTS BY REGION OF A ONE DOLLAR INCREASE IN FEDERAL GRANTS TO REGIONAL GOVERNMENT k

	(1) Initial Income Effect	(2) Initial Plus Direct Plus Indirect Income Effect	(3) Initial Plus Direct Plus Induced Income Effects*
(1) Unconditional grant to government k	${}_1\underline{Y}^k_u = \hat{\underline{\underline{V}}}_G \hat{\underline{\underline{H}}}_{Gu} \bar{\underline{\Gamma}}^k_u$	${}_2\underline{Y}^k_u = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}^k_u + {}_1\underline{Y}^k_u$	$\tilde{\underline{X}}^k_u = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\underline{\underline{D}}_1]^{-1} \tilde{\underline{\underline{T}}} \, \hat{\hat{\underline{\underline{G}}}} \, \hat{\underline{\underline{H}}}_{Gu} \bar{\underline{\Gamma}}^k_u$
(2) Conditional non-matching grant for program K, government k, case 1 and case 2	${}_1\underline{Y}^k_{NK} = \hat{\underline{\underline{V}}}_G \widehat{\underline{\underline{H}}'}_{GN} \bar{\underline{\Gamma}}^k_{NK}$	${}_2\underline{Y}^k_{NK} = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}^k_{NK} + {}_1\underline{Y}^k_{NK}$	$\tilde{\underline{X}}^k_{NK} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\hat{\underline{\underline{D}}}_1]^{-1} \tilde{\underline{\underline{T}}} \, \hat{\hat{\underline{\underline{G}}}} \, \widehat{\underline{\underline{H}}'}_{GN} \bar{\underline{\Gamma}}^k_{NK}$
(3) Open-ended matching grant for program K, government k	${}_1\underline{Y}^k_{OK} = \hat{\underline{\underline{V}}}_G \widehat{\underline{\underline{H}}'}_{po} \underline{P}^k_{OK}$	${}_2\underline{Y}^k_{OK} = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}^k_{OK} + {}_1\underline{Y}^k_{OK}$	$\tilde{\underline{X}}^k_{OK} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\hat{\underline{\underline{D}}}_1]^{-1} \tilde{\underline{\underline{T}}} \, \hat{\hat{\underline{\underline{G}}}} \, \widehat{\underline{\underline{H}}'}_{Po} \underline{P}^k_{OK}$
(4) Close-ended matching grant for program K, government k, case 1 or case 2, $d\omega^k_K$	${}_1\underline{Y}^k_{CK} = \hat{\underline{\underline{V}}}_G \widehat{\underline{\underline{H}}'}_{pc} \underline{P}^k_{CK}$	${}_2\underline{Y}^k_{CK} = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}^k_{CK} + {}_1\underline{Y}^k_{CK}$	$\tilde{\underline{X}}^k_{CK} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\hat{\underline{\underline{D}}}_1]^{-1} \tilde{\underline{\underline{T}}} \, \hat{\hat{\underline{\underline{G}}}} \, \widehat{\underline{\underline{H}}'}_{PC} \underline{P}^k_{CK}$
(5) Close-ended matching grant for program K, government k, case 3 or case 2, $d\bar{\Gamma}^k_{KC}$	${}_1\underline{Y}^k_{CK} = \hat{\underline{\underline{V}}}_G \widehat{\underline{\underline{H}}'}_{GC} \bar{\underline{\Gamma}}^k_{CK}$	${}_2\underline{Y}^k_{CK} = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}_{CK} + {}_1\underline{Y}^k_{CK}$	$\tilde{\underline{X}}^k_{CK} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\hat{\underline{\underline{D}}}_1]^{-1} \tilde{\underline{\underline{T}}} \, \hat{\hat{\underline{\underline{G}}}} \, \widehat{\underline{\underline{H}}'}_{GC} \bar{\underline{\Gamma}}^k_{CK}$

* Includes both production and income effects

Direct employment income is the employment income which is generated in the first spending round by a regional government. This income is wage value-added in the final sectoral purchases of the regional government, i.e., regional government final demand. In this case, wage value-added is the employment income created through satisfying regional government final demands before intermediate demand is satisfied.

Indirect employment income is the wage bill paid to labour in the intermediate production sectors which have been stimulated by increased final demands. Thus, the latter two income effects represent the wage value-added component in the increased production of direct plus indirect output, ${}_2\underline{X}$.

In general, the IDI employment income effect of an increase in regional government expenditure is

$$(5.50a) \qquad {}_2\underline{Y} = \hat{\underline{\underline{V}}}_X \; {}_2\underline{X} + \hat{\underline{\underline{V}}}_G \cdot d(\underline{E}) \; .$$

${}_2\underline{Y} = [d_2y^k]$ is a mx1 column vector which summarizes the increase in IDI employment income in each region.

Substituting equation (5.43a) for ${}_2\underline{X}$ in equation (5.50a), the relationship between the IDI employment income effect and changes in regional government final demand is elaborated. This relationship is

$$(5.50b) \qquad {}_2\underline{Y} = \hat{\underline{\underline{V}}}_X \; [\hat{\underline{\underline{I}}} - \underline{\underline{T}} \; \hat{\underline{\underline{A}}}]^{-1} \; \underline{\underline{T}} \; \hat{\underline{\underline{G}}} \cdot d(\underline{E}) + \hat{\underline{\underline{V}}}_G \cdot d(\underline{E}) \; .$$

To illustrate the calculation of the IDI employment income effect, consider a one dollar increase in the unconditional grant to regional government k. In this case, the change in government expenditure, $d(\underline{E})$, is described by equation (5.42b). In addition, the direct plus indirect production effect of this grant is described by equation (5.43b). Substituting these values of $d(\underline{E})$ and ${}_2\underline{X}_u^k$ into equation (5.50a), the IDI employment income effect is obtained. This income effect is

$$(5.50c) \qquad {}_2\underline{Y}_u^k = \hat{\underline{\underline{V}}}_X \, {}_2\underline{X}_u^k + \hat{\underline{\underline{V}}}_G \, \hat{\underline{\underline{H}}}_{Gu} \, \bar{\underline{\Gamma}}_u^k \, .$$

Here, the last term on the right-hand side of (5.50c) represents the initial income effect, ${}_1\underline{Y}_u^k$, described in equation (5.49b). A typical element of the ${}_2\underline{Y}_u^k$ vector, $d({}_2y^k)$, is

$$(5.50d) \qquad d({}_2y^k) = \sum_{i=1}^{n} a_{wi}^k \cdot d({}_2x_i^k) + d({}_1y^k) \; .$$

The IDI employment income effect, therefore, depends jointly on the initial income effect, the DI production effect, and labour value added.

However, the IDI measure of employment income discussed in this section does not accurately measure the impact of federal grants on regional income. It does not consider the induced production and income arising from endogenous increases in personal consumption. Thus, the IDI employment income effect understates the employment income in each region generated by an increase in a federal grant. A measure of the IDII employment income effect is developed in the following section to correct this shortcoming.

The Initial Plus Direct Plus Induced Employment Income Effect

The IDII income effect describes the payments to labour from three sources:

1. the provision of a regional government program,
2. the production activity necessary to satisfy regional

government final demand, and

3. the production required to meet intermediate demand.

The distinguishing feature of IDII employment income effect is the endogenous treatment of the personal consumption component of intermediate demand. Thus, IDII employment income effects are calculated from the Keynesian-Leontief I-O model.

In this model, the IDII employment income effects are derived from equation (5.40) in Section 5.5.3. Thus, the IDII employment income effects which are presented here are equivalent to a change in personal income. These changes in personal income are induced by a one dollar increase in a federal grant to a regional government. The personal income which is generated in each region from an increase in a federal grant is summarized in equation (5.44a) of Section 5.7.1,

$$(5.44a) \qquad \underline{\tilde{X}} = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\, \hat{\underline{\underline{D}}}_1]^{-1}\, \tilde{\underline{\underline{T}}}\, \hat{\tilde{\underline{\underline{G}}}} \cdot d(\underline{E}) \; .$$

The change in personal income in each of the m regions is summarized by every (n+1)th element in the m(n+1) column vector $\underline{\tilde{X}}$, $d(\nu^k)$.

For purposes of exposition, consider the personal income effects of a one dollar increase in the unconditional grant to regional government k. These income effects are calculated in equation (5.44b) in Section 5.7.1. The change in personal income from this grant is represented in each (n+1) element of $\tilde{\underline{X}}_u^k$.

$$(5.44b) \qquad \tilde{\underline{X}}_u^k = [\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\, \hat{\underline{\underline{D}}}_1]^{-1}\, \tilde{\underline{\underline{T}}}\, \hat{\tilde{\underline{\underline{G}}}}\, \hat{\underline{\underline{H}}}_{Gu}\, \bar{\underline{\Gamma}}_u^k$$

A typical element of $\tilde{\underline{X}}_u^k$ which summarizes the change in personal income in region 1 which is generated by a one dollar increase in the unconditional grant to regional government k, $d(\nu^1)$, is

$$(5.51) \qquad d(\nu^1) = \sum_{i=1}^{m(n+1)} d_{n+1,i} \; g_i^{rk} \; d(\Gamma_u^k)$$

where dn+1,i is the ith element in the (n+1)th row of $[\hat{\underline{\underline{I}}} - \tilde{\underline{\underline{T}}}\,\hat{\underline{\underline{D}}}_1]^{-1}$,

and

g_i^{rk} is the regional government final demand coefficient which is defined in equation (5.17a) in Section 5.4.

From equation (5.51), it is apparent that the increase in personal income in region 1 depends upon the IDI production effect and the initial employment income effect in that region.

The increase in personal income induced by a one dollar increase in other federal grants to regional government k is presented in column 3 of Table 5.3.

5.7.4 Conclusion

This concludes the discussion of the production and employment income effects which result from changes in government expenditure induced by changing levels of federal grants to regional governments. Two production and employment income effects by industry have been presented:

1. the direct plus indirect effect, DI and DI_i respectively, and
2. the direct plus indirect plus induced effect, DII and DII_i respectively.

The production effects which indicate the output generated in each industry in each region form the basis from which the employment income effects are calculated. In addition, three total employment income effects by region have been derived in this section:

1. the initial effect,

2. the initial plus direct plus indirect effect, IDI, and

3. the initial plus direct plus induced effect, IDII.

The major component of the latter two employment income effects by region is the employment income accruing in each industry. Thus, it is apparent that the production and employment income effects are interrelated. Each effect is interregional in nature. Each effect indicates the interregional distribution of production activity and employment income generated by changes in a federal grant to one specific region.

Of the production effects, the DII production effect most accurately describes the interregional distribution of economic activity. This accuracy is the consequence of treating personal consumption as an endogenous sector of the I-0 model. Similarly, the DII_i employment income effects by industry which account for the endogenous increase in personal consumption most accurately describe the income accruing to labour employed in each industry. Moreover, the IDII employment income effect which equals the personal income derived from the Keynesian-Leontief I-0 model, most accurately describes the interregional employment income distribution induced by changes in a federal grant.

5.8 Summary

In this chapter, two interregional I-0 models have been developed to analyze the interregional production and employment income effects of federal grants to regional governments. These models are:

1. the Basic I-0 model which treats personal consumption as exogenous, and

2. the Keynesian-Leontief I-0 model which includes personal consumption as an endogenous sector.

Both models include a regional government final demand sector for which a behavioral model has been developed, and a sector of all other final demands which has not been explained behaviorally. The I-0 models have general equilibrium features; the equilibrium quantities of goods supplied and demanded by all industries, and the equilibrium quantities of labour demanded and supplied in all regions are determined. However, other general equilibrium aspects are not treated in the model. For example, the investment sector, taxes, and the interregional movement of labour in response to regional differences in wages are excluded from the model.

Applying changes in regional government expenditure to the I-0 models, the interregional production and employment income effects of changes in federal grants to regional governments were described.

The financing arrangements of these federal grants are not considered. If the grants are financed out of federal general revenue, each region contributes to the financing of the grant program. These contributions take the form of all non-earmarked federal taxes collected within the region. A complete analysis of these financing arrangements would require the simultaneous determination of (1) the negative production and income effects of the increased federal taxes, e.g., sales taxes, personal and corporate income taxes, etc., and (2) the positive production and income effects of the federal grants in a general equilibrium model. As the tax effects are not excluded in this model, the production and income effects which are derived here overstate the actual impact of federal grants financed by taxation.

In the next chapter, these I-0 models are specified for Canada. In addition, Canadian estimates of the regional government expenditure functions are reported.

Footnotes to Chapter 5

[1]This is illustrated for commodity i. Let $(x^o_{1i},\ldots,x^o_{ni},\ w^o_i,\ v^o_i)$ be the optimum input combinations for the production of one unit of x_i. The corresponding variable production cost, ϕ_1, for this unit of output is

(1) $$\phi_i = (a_{v1}x^o_{1i} + \ldots + a_{vw}\, w_i + a_{vv}\, v^o_i)$$

where a_{vj}, j=1,...,n, is the price of input j. As the production function is homogenous and the expansion path in $x_{1i},\ldots,\ w_i$ space is linear, the production function and total variable cost, Ψ_i, can be written as

(2) $$x_i = f(\lambda x^o_{1i},\ldots,\lambda x^o_{ni},\lambda w^o_i,\lambda v^o_i) = \lambda^k$$

and

(3) $$\Psi_i = (a_{v1}x^o_{1i} + \ldots + a_{vn}x^o_{ni} + a_{vw}w^o_i + a_{vv}v^o_i)\lambda = \phi_i\lambda$$

Solving for λ in the production equation and substituting for λ in the total variable cost equation, the cost equation is written as

(4) $$\Psi_i = \phi_i x_i^{1/k} .$$

The first order partial derivative of total variable cost, the marginal cost, is

(5) $$\frac{\partial\Psi_i}{\partial x_i} = \frac{\phi_i}{k}\, x_i^{(1-k)/k} ;$$

and the second order partial derivative, the change in marginal cost, is

(6) $$\frac{\partial^2\Psi_i}{\partial x_i} = \frac{\phi_i(1-k)}{k^2}\, x_i^{(1-2k)/k} .$$

As the production function exhibits constant returns to scale, i.e., k = 1, the marginal cost and second order derivative are equal to

(5a) $$\frac{\partial\Psi_i}{\partial x_i} = \phi_i$$

and

(6a) $$\frac{\partial^2\Psi_i}{\partial x_i^2} = 0 .$$

Footnotes to Chapter 5

[1]This is illustrated for commodity i. Let $(x^o_{1i},\ldots,x^o_{ni}, w^o_i, v^o_i)$ be the optimum input combinations for the production of one unit of x_i. The corresponding variable production cost, ϕ_1, for this unit of output is

(1) $\phi_i = (a_{v1}x^o_{1i} + \ldots + a_{vw}\,w_i + a_{vv}\,v^o_i)$

where a_{vj},j=1,...,n, is the price of input j. As the production function is homogeneous and the expansion path in $x_{1i},\ldots, w_i$ space is linear, the production function and total variable cost, Ψ_i, can be written as

(2) $x_i = f(\lambda x^o_{1i},\ldots,\lambda x^o_{ni},\lambda w^o_i,\lambda v^o_i) = \lambda^k$

and

(3) $\Psi_i = (a_{v1}x^o_{1i} + \ldots + a_{vn}x^o_{ni} + a_{vw}w^o_i + a_{vv}v^o_i)\lambda = \phi_i\lambda$

Solving for in the production equation and substituting for λ in the total variable cost equation, the cost equation is written as

(4) $\Psi_i = \phi_i x_i^{1/k}$.

The first order partial derivative of total variable cost, the marginal cost, is

(5) $\frac{\partial\Psi_i}{\partial x_i} = \frac{\phi_i}{k}\, x_i(1-k)/k;$

and the second order partial derivative, the change in marginal cost, is

(6) $\frac{\partial^2\Psi_i}{\partial x_i} = \frac{\phi_i(1-k)}{k^2}\, x_i^{(1-2k)/k}$.

As the production function exhibits constant returns to scale, i.e., k = 1, the marginal cost and second order derivative are equal to

(5a) $\frac{\partial\Psi_i}{\partial x_i} = b_i$

and

(6a) $\frac{\partial^2\Psi_i}{\partial x_i^2} = 0$.

Thus, the marginal cost of producing output x_i is constant. This indicates that the supply curve for x_i is infinitely elastic.

[2]This assumption is required because the investment sector is excluded from the empirical I-O model. Thus, no relationship between personal income and distributed profits is formulated in this theoretical I-O model.

[3]Unless otherwise specified, the notation used in developing the interregional I-O model is:

1) double underlining denotes a matrix,
2) single underlining denotes a vector,
3) a hat "^" denotes a diagonal or block diagonal matrix,
4) superscripts denote regions, and
5) subscripts denote industries, government services, or other final demand categories.

[4]The interregional I-O model presented in equation (5.13) can also be derived from the interregional I-O tables. This approach is elaborated in Moses (1955).

[5]Stone, Richard, Input-Output and National Accounts, (Paris, Organization for European Economic Cooperation, 1961), p. 14.

[6]Miyazawa has objected to this form of the Keynesian-Leontief I-O model because of the variability of marginal propensities to consume. While acknowledging Miyazawa's criticisms, the standard approach to endogenizing the personal consumption sector is retained. This standard approach is consistent with the I-O data described in Chapter 6.

[7]The inclusion of savings in a static utility function within the context of intertemporal utility maximization is discussed by Grandmont (1974).

[8]Here, the reduction in the matching ratio is just sufficient to increase the value of the matching grant by one dollar, $\$1 = \omega_K^k P_K^k g_K^k$.

[9]In the case of open- or closed-ended matching grants, the ω_K^k element equals $\frac{1}{P_K^k g_K^k}$.

Chapter 6

EMPIRICAL MODELS OF REGIONAL GOVERNMENT FISCAL RESPONSE TO FEDERAL GRANTS AND THE INTERREGIONAL INPUT-OUTPUT MODEL, 1965

6.1 Introduction

In this chapter an empirical model of the interregional impact of federal grants to Canadian regional governments is presented. The presentation of this model illustrates how the methodological approach to the analysis of federal grants which was developed in Chapters 4 and 5, can be empirically implemented for four Canadian regions and the United States. The four Canadian regions are: the Atlantic provinces, Quebec, Ontario, and Manitoba.[1] In addition, the empirical model provides estimates of the coefficients of regional government fiscal response to federal grants and provides other data which are necessary in calculating the interregional income effects of federal grants.

As in the theoretical model of the interregional income effects of federal grants which was presented in Chapters 4 and 5, the empirical model presented here is divided into two general sub-models. The first sub-model is a behavioral model of regional government fiscal response to federal grants. This empirical model of fiscal response differs in several important respects from the theoretical model of fiscal response which was presented in Chapter 4. Briefly, in the empirical model, all types of conditional grants for a specific expenditure program are aggregated and estimated as broad conditional grants. In addition, in the empirical model, regional government non-grant revenue is permitted to change as regional governments alter their program expenditure in response to changes in federal grants. This is in contrast to the theoretical model in which regional governments re-allocate a constant non-grant revenue between programs.

The second sub-model presented in this chapter is an inter-regional I-O model in which changes in regional government expenditure are translated into interregional employment income effects. Two I-O models are presented: first, a model with an exogenous personal consumption sector--the Basic I-O model--, and second, a model with an endogenous personal consumption sector--the Keynesian-Leontief I-O model. In constructing these I-O models, emphasis is placed on providing a detailed account of regional government final demand expenditure. Each regional government is considered to make an expenditure on five programs: health, social welfare, education, transportation-communication, and other programs. Furthermore, fiscal response matrices are constructed to facilitate the analysis of four federal grants: unconditional grants, conditional health grants, conditional social welfare grants, and conditional education grants.

The empirical model of regional government fiscal response is presented in Section 6.2. In Section 6.3, the Basic I-O model of the Canadian and United States economies is discussed. The Keynesian-Leontief I-O model is presented in Section 6.4. Conclusions are presented in Section 6.5.

6.2 Regional Government Fiscal Response to Federal Grants

In this section, the empirical model of regional government expenditure is described. This model emphasizes the fiscal response of four Canadian regional governments to federal grants. The four Canadian regional governments analyzed are: the Atlantic Provinces, Quebec, Ontario, and Manitoba.[2] Expenditure by the United States is not analyzed.

The model of regional government expenditure is estimated for the purpose of obtaining data which are useful in illustrating the empirical implementation of the I-O models. No attempt is made to estimate a model which provides a complete behavioral analysis of the regional government sector; rather, a simple, linear model of fiscal response is estimated for each of the four Canadian regional governments included in the model. The structure of the estimated model is presented in Section 6.2.1. In Section 6.2.2, the estimated coefficients of fiscal response are presented and interpreted.

6.2.1 The Model

In this section, the behavioral model of regional government fiscal response to federal grants is presented. Expenditure equations for five programs are estimated for each Canadian regional government which is included in the model. These programs are: health, social welfare, education, transportation-communication, and other programs. The estimated model differs in several ways from the theoretical model of regional government fiscal response to federal grants which was developed in Chapter 4. First, the expenditure equations which are estimated for each regional government are not estimated as a Linear

Expenditure System. The absence of readily available data on the prices of regional government programs prevents the estimation of the expenditure equations which were derived in Chapter 4. Moreover, the five expenditure equations for each regional government are estimated individually rather than as a system of equations.

Second, regional government non-grant revenue is allowed to change as regional governments alter their expenditure in response to changes in federal grants. This formulation of the fiscal response model allows regional governments to adjust (a) their expenditure on each program, (b) their tax effort, and (c) their indebtedness as federal grants are changed. This model in which regional governments can adjust their non-grant revenue as federal grants are changed is more realistic than the model in which non-grant revenue cannot be adjusted (Chapter 4).

Third, in the empirical model, conditional grants are defined by general program type, e.g., conditional health grants. This broad definition of conditional grants is in contrast to the specific grant types defined in the theoretical model, e.g., open-ended matching grants for diagnostic health services. Similarly, regional government expenditure is also defined in terms of general expenditure programs, e.g., health expenditure, rather than specific sub-programs such as diagnostic health services. These broad and somewhat heterogeneous grant and expenditure categories are employed because only this grouping of sub-programs is compatible with the data on regional government final demand expenditure employed in constructing the I-O models.

Finally, demographic characteristics of the region are included explicitly in the expenditure equations estimated for the corresponding regional government. In the theoretical model of fiscal response, demographic characteristics of a region are included implicitly in the minimum level of program expenditure, $P_I^k \beta_I^k$, for each program. Given the structure of the estimated expenditure equations, the demographic characteristics must be included explicitly.

In formulating the model of regional government expenditure, two alternative hypotheses are made. These hypotheses are now listed.

Hypothesis One: each regional government's per capita expenditure on a program is a linear function of the regional government's ability to raise revenue through taxation and borrowing from own sources, per capita federal grants, select demographic characteristics of the region, the cost of providing the program in the region, and a general growth trend in regional government expenditure.

Hypothesis Two: the per capita program expenditure by a regional government is positively related to the regional government's ability to raise revenue through taxation and borrowing from own sources, and to per capita federal grants.

No hypothesis is formulated concerning the direction of the relationship between regional government expenditure and the cost of providing the program, i.e., the price of the program. In nominal terms, an increase in the price of a program will result in an increase in expenditure on the program if the regional government's demand for the program is inelastic. Similarly, if the regional government has an elastic demand for a program, an increase in the price of this program will result in a reduction in expenditure on the program. As there is no *a priori* reason to assume that the demand for programs by a regional government is elastic or inelastic, no hypothesis is formulated concerning the sign of the cost coefficient.[3]

No hypothesis is made concerning the expected sign of the demographic coefficients in each expenditure equation. The sign of these coefficients depends upon the specific program and demographic characteristic,[4] and upon the presence of economies or diseconomies of scale in providing programs.[5] There is no _a priori_ reason to assume the existence of economies or diseconomies of scale in providing specific programs in a region. Thus, hypothesis concerning the relationship between demographic variables and regional government program expenditure is not formulated.

The issues concerning the expected sign of select independent variables are discussed in greater detail in Appendix B.

Several of the independent variables included in these hypotheses are not quantifiable or are not available because of limitations of the data. Thus, in the estimated equations several independent variables are represented with surrogate variables. Four surrogate variables are employed in this model. First, the surrogate variable which is employed to represent the ability of a regional government to raise revenue from own sources is the per capita personal income net of federal taxes[6] in the region. Second, the cost of providing a program in a region is represented by the average weekly wage and salary in the region. This specific surrogate variable is employed to represent program costs or prices because other quantifiable cost variables, e.g., a wholesale price index, are not readily available for each region.[7] Third, the set of demographic characteristics included in an expenditure equation summarizes the non-economic variables which influence regional government expenditure on the program. Examples of these demographic variables are: population density and degree to which a region is urbanized, the percent of regional population which is of school age or working age, and the number of automobile registrations per 1,000 residents. Fourth, the general trend in regional government expenditure is represented by a time trend variable. Thus, the model includes both economic and non-economic determinants of regional government expenditure. These surrogate variables summarize the information which is contained in the non-quantifiable variables or variables for which data are not readily available.

The general form of the expenditure equations which are estimated for Quebec, Ontario, and Manitoba, is now discussed. This general expenditure equation for program I, I=1,...,5, in region k, k = Quebec, Ontario, and Manitoba, is presented in equation (6.1),

$$(6.1) \quad E_I^k = \alpha_{I0}^k + \beta_{I1}^k Y^k + \beta_{I2}^k UG^k + \sum_{K=3}^{7} \beta_{IK}^k CG_K^k + \sum_{j=b}^{c} \beta_{Ij}^k D_j^k + \beta_{Iw}^k w^k + \beta_{It}^k t + \mu_I^k$$

where E_I^k is the per capita expenditure by regional government k on program I;

Y^k is the per capita personal income net of federal taxes in region k;

UG^k is the per capita unconditional grant to regional government k;

CG_K^k is the per capita conditional grant, of type K, to regional government k. The five conditional grants are: health grants, social welfare grants, education grants, transportation-communication grants, and natural resource-primary industry development grants;

D_j^k is the variable which summarizes the jth demographic characteristic in region k;

w^k is the average weekly wage and salary in region k;

t is time; and

μ_I^k is the stochastic error term.

These equations for Quebec, Ontario, and Manitoba are estimated for time series data, 1947 through 1965, using Ordinary Least Squares (OLS). The time period 1947 through 1965 is chosen for two reasons. First, the 1947 federal-provincial fiscal agreement marked the beginning of a new era in federal tax rental and equalization payments to the regional governments. Second, a set of annual economic and demographic data which is based on the fiscal year is available in Maley (1972) for the years 1947 through 1965.[8]

For the Atlantic provices, the expenditure equations are estimated by OLS using pooled cross-section time-series data, 1947 through 1965. This estimation procedure is employed because the four Atlantic provinces are analyzed as a single region, the Atlantic provinces.[9] Here, it is assumed that the determinants of regional government program expenditure are the same in each of the four sub-regions, i.e., provinces included in this region. Furthermore, each of these sub-regional governments has the same fiscal response to a change in a federal grant. However, structural differences in government expenditures may exist between these sub-regions. These potential structural differences are summarized in three provincial dummy variables, R^r, r = 1,...3, which are included in each expenditure equation for the Atlantic provinces. These dummy variables take a value of either 1 or 0. The expenditure equation which is estimated for each program, I, in the Atlantic provinces is given in equation (6.2),

$$(6.2) \qquad E_I = \alpha_{I0} + \beta_{I1}Y^k + \beta_{I2}UG^k + \sum_{K=3}^{7} \beta_{IK}CG_K^k + \sum_{j=b}^{c} \beta_{Ij}D_j^k + \beta_{Iw}w^k + \beta_{It}t + \sum_{r=1}^{3} \beta_{IR}^r R^r + \mu_I^k.$$

The five expenditure equations which are estimated for each region are presented in Appendix B.

From equations (6.1) and (6.2), and the description of conditional grant variables in these equations, it is obvious that this formulation of the regional government expenditure equations obscures the impact of each individual type of conditional grant on regional government expenditure. In addition, an unconstrained estimation procedure is employed. For example, the sum of the conditional health grant coefficients is not constrained to unity, i.e., $\sum_{I=1}^{5} \beta_{IK}^k \neq 1$. Thus, regional governments are implicitly allowed to adjust their non-grant revenue as federal grants are altered. In these respects, the estimated model of fiscal response differs from the theoretical model of fiscal response (Chapter 4).

This estimation of the regional government fiscal response model by OLS may give rise to a number of statistical problems. For example, if the error terms in the five expenditure equations which are estimated for a region are correlated across equations, the regression coefficients will be inefficient. In this event, the five equations for each region should be estimated as a system of equations. The appropriate estimation procedure in this case is Generalized Least Squares (Johnston, 1973, p. 238).

Secondly, regional government expenditure, personal income net of federal taxes in the region, and federal conditional grants may be simultaneously determined. In the event of this simultaneity, the application of OLS can give inconsistent regression coefficients. Here, the appropriate estimation procedure involves:

1. specifying six additional equations which explain separately each conditional grant and personal income net of federal taxes, and
2. the estimation of all equations using Two Stage Least Squares.

Despite these statistical problems, the OLS version of the model is retained for several reasons. First, the choice of appropriate instrumental variables is complex and may not avoid the simultaneity problem. Gramlich (1969, p. 581) has suggested a widely adopted practice of employing the conditional grant matching ratio, ω_I^k, and the maximum value of the grant, $\bar{\Gamma}_I^k$, as instrumental variables for open-ended conditional grants and closed-ended conditional grants respectively.[10] However, the expenditure programs which are defined in this study are broad, heterogeneous programs, e.g., health expenditures, which are financed by a variety of conditional grants. Thus, these instrumental variables for each broadly defined program must be formed as the weighted sum of constituent matching ratios and maximum grants. The weights employed in forming these variables are: the importance of the constituent program expenditure supported by the grant relative to total program expenditure. Their weights cannot be expected to remain constant as program expenditure is changed. Thus, it appears to be impossible to include matching ratios and maximum grants, themselves, in the estimated equations. Following Maley (1972), the conditional grants are retained as independent variables in the estimated regional government expenditure equations.[11]

Secondly, the tractability of estimating the model as a simultaneous system of equations must be considered. Clearly, the behavioral model of regional government expenditure is more realistic if the simultaneous system approach is adopted. However, this increase in realism is accompanied by an increase in the complexity of the model and the estimation procedure. The model of regional government expenditure is estimated solely for the purpose of obtaining previously unavailable approximations of regional government fiscal response to federal grants to use with the interregional I-O model. It has not been estimated with the explicit intention of providing a general behavioral model of the regional government sector of the economy. The increase in complexity associated with the estimation of the regional government sector as a simultaneous system implies a great commitment of resources. Two Ph.D. dissertations, Maley (1972) and Hardy (1973), have been undertaken for the sole purpose of estimating single equation models of the fiscal response of provincial governments to federal grants. A thorough analysis of the fiscal response of the four Canadian regional governments to federal grants is beyond the scope of this dissertation. Moreover, the limited resources available for the completion of this dissertation are not adequate to undertake an empirical investigation of such magnitude.

Thus, the behavioral model of regional government fiscal response is estimated by OLS. To the extent that the stochastic error terms are correlated across equations and that regional government expenditure, personal disposable income after federal taxes, and federal grants to regional governments are determined simultaneously, the estimated fiscal response coefficients must be interpreted with caution.

In the next section, the estimated coefficients of regional government fiscal response to federal grants are presented and discussed.

6.2.2. The Estimated Fiscal Response Coefficients

In this section, the estimated coefficients of regional government fiscal response to federal grants are presented and discussed. These coefficients are estimated using the behavioral model of regional government expenditure outlined in Section 6.2.1. The response coefficients of the four regional governments to marginal per capita increases in four federal grants are presented in Table 6.1. The four federal grants included in Table 6.1 are unconditional grants, conditional health grants, conditional social welfare grants, and conditional education grants. The total impact on per capita program expenditure due to an increase in a grant is described by the coefficients in each column. An asterisk (*) accompanying an entry in this table indicates that the associated grant coefficient is statistically different from zero at the five percent level on the two-tailed test. Each of these grants is now discussed.

Consider the per capita regional government expenditure which is induced by an increase of one dollar per capita in unconditional grants. The extent of variation in regional government expenditure which is induced by this change in unconditional grants is illustrated in the first column of Table 6.1. In most regions, the fiscal response coefficients indicate that unconditional grants generate an increase in regional government expenditure. However, these increases in expenditure are less than the increases in the unconditional grants. During the time period studied, regional governments appear to have substituted unconditional grant revenue for own taxation and indebtedness. Furthermore, unconditional grants appear to have a differential impact on regional government expenditure. These differences are apparent in a comparison of fiscal response by program and by region. Considering only the response coefficients which are statistically different from zero, the Quebec government exhibits the greatest fiscal response to unconditional grants. A one dollar per capita increase in unconditional grants induces the Quebec government to increase per capita expenditure on education by $0.64. Following Gramlich (1969), it is implied from these coefficients that the Quebec government has a positive income elasticity for education programs.

Smaller significant coefficients are recorded for the Atlantic provinces and Manitoba. In the Atlantic provinces, regional governments are induced to increase per capita social welfare and transportation expenditure by $0.08 and $0.46, respectively.

In contrast, the Manitoba government increases per capita social welfare expenditure by $0.33 and reduces per capita health expenditure by $0.16. These coefficients imply that both the Atlantic provinces and Manitoba governments have a positive income elasticity of demand for social welfare programs during the time period of this study.

In addition, the Atlantic provinces appear to have a positive income elasticity for transportation programs while the Manitoba government appears to have a negative income elasticity for health programs during the time period studied.[12]

In contrast to the Atlantic provinces, Quebec, and Manitoba, none of the unconditional grant coefficients for Ontario is statistically significant at the five percent level. Thus, the Ontario government appears to have a zero income elasticity for all programs during the time period 1947 through 1965 (Gramlich, 1969). The increased grant revenue probably manifests itself in a reduced tax effort and/or is used to reduce regional government indebtedness.

The fiscal responses of the Atlantic provinces, Quebec, Ontario, and Manitoba indicate that unconditional grants have a dampening effect on regional government expenditure. These governments appear to use some portion of unconditional grants to reduce their tax effort or indebtedness. In addition, the fiscal response of regional governments to unconditional grants is seen to be varied.

The remaining three columns in Table 6.1 indicate the responses of regional governments to marginal per capita changes in conditional grants. As in the case of unconditional grants, each regional government exhibits a unique response to increases in conditional grants. Conditional grants may influence regional government expenditure on both supported and non-supported programs. First, consider the impact which each of these grants has on the supported program expenditure. The region most responsive to increases in conditional grants is Manitoba. A one dollar per capita increase in health grants to Manitoba induces the regional government to increase expenditures on health, the supported program, by $2.07 per capita. In contrast, an equivalent increase in the social welfare and education grants to Manitoba motivates an increase in per capita expenditure of $1.58 on social welfare, and $4.48 on education programs respectively. Each of these grant coefficients is statistically different from zero at the five percent level.

A smaller increase in government expenditure is observed in the other three regions. However, the expenditure response by each of these three regional governments to each grant is unique. Increased health grants induce larger per capita expenditures in Ontario than in Quebec or the Atlantic provinces. However, for increases in education and social welfare grants, the largest responses are observed in the Atlantic provinces. Thus, within each region the level of increased expenditure induced by changes in conditional grants depends on the nature of the grant. At the same time, for each conditional grant, the level of response varies among the regions.

Conditional matching grants can be grouped according to the impact of these grants on supported program expenditure. As the social welfare and education grants are exclusively matching grants, these grants are classified according to the fiscal response coefficient.[14] If this coefficient is less than unity, federal grants are seen to be <u>substitutes</u> for the regional government's own expenditure (Gramlich, 1969, pp. 582-573). For example, this is the case for social welfare expenditure in Quebec. In addition, if the grant coefficient is greater than unity and less than the reciprocal of the conditional matching grant ratio, $\frac{1}{k_{\omega_I}}$, the grant exhibits a <u>limited stimulation</u> of

TABLE 6.1

UNCONDITIONAL AND CONDITIONAL GRANT COEFFICIENTS

	Type of Grant			
	Unconditional	Health	Social Welfare	Education
Atlantic Provinces				
Health	0.11	1.80*	0.07	0.07
Social Welfare	0.08*	0.07	1.32*	0.02
Education	0.05	0.02	1.01*	1.45*
Transportation	0.46*	-0.98	0.38	0.82
Other	0.15	0.20	0.72	0.06
Quebec				
Health	0.04	1.03*	-0.08	-1.23
Social Welfare	0.15	-0.22	0.81*	0.07
Education	0.64*	0.63*	-0.45	2.51
Transportation	-0.45	-0.45	0.16	-0.04
Other	-0.03	-0.44	0.20	2.28*
Ontario				
Health	0.02	2.12*	-0.35	0.07
Social Welfare	-0.02	0.08*	1.17*	-0.06*
Education	0.01	0.15	0.24	1.11*
Transportation	-0.10	-0.44	-0.58	-0.23
Other	-0.19	0.25*	0.19	-0.01
Manitoba				
Health	-0.16*	2.07*	0.08	0.48
Social Welfare	0.33*	0.22*	1.58*	0.41
Education	-0.20	1.51*	0.64	4.48*
Transportation	-0.50	0.40	-0.15	-1.36
Other	0.80	0.47	2.53*	-2.92

* Indicates coefficients statistically different from zero at the five percent level.

regional government expenditure from own revenue (Gramlich, 1969, pp. 572-573). The social welfare grants to the Atlantic provinces, Ontario, and Manitoba, and the education grants to the Atlantic provinces and Ontario are examples of a conditional grant with limited stimulation effects. The matching ratios for these two types of grants are approximately 0.5. Furthermore, a grant coefficient which is greater than the reciprocal of the conditional grant matching ratio indicates that the grant is complementary (Gramlich, 1969, pp. 572-573). For example, the education grant to Manitoba appears to be complementary. This classification of expenditure coefficients further highlights the diverse fiscal response of regional governments to federal conditional grants.[15]

Secondly, consider the leakage and seepage effects of conditional grants on non-supported program expenditure by regional governments. These leakage and seepage effects of conditional grants to non-supported programs are also displayed in the last three columns of Table 6.1. In general, conditional health grants include the greatest regional government expenditure on non-supported programs, e.g., non-health programs (leakage). Three regional governments, Quebec, Ontario, and Manitoba, increase their expenditure on non-supported programs as conditional health grants are increased. The largest increase in non-supported program expenditure is undertaken by the Manitoba government as conditional health grants are increased by one dollar per capita. In this region, expenditure is increased on two non-supported programs: social welfare, $0.22, education, $1.51. In contrast, an equivalent increase in health grants to Ontario appears to induce an increase in expenditure on two non-supported programs, social welfare, \$0.08, and other programs, \$0.25. The fewest leakages occur in Quebec where education expenditure is increased by \$0.63 per capita for an equivalent increase in conditional health grants.

Conditional social welfare and education grants also influence regional governments to increase expenditure on non-supported programs. However, the leakage from these grants is more limited than the laakage from conditional health grants. For social welfare and education grants, leakage effects are reported in two and one region, respectively. A one dollar per capita increase in the social welfare grant to Manitoba appears to induce a per capita increase in other program expenditure of \$2.53, while an equal increase in this grant to the Atlantic provinces generates a \$1.01 increase in education expenditure. The one dollar increased education grants to Quebec appear to generate a \$2.28 increase in other program expenditure.[16] In contrast, a one dollar per capita increase in the education grant to Ontario generates a seepage of \$0.06 per capita from social welfare expenditure. No other leakages or seepages appear to be generated by federal conditional grants to regional governments. Thus, conditional grants appear to have a wide ranging and diverse impact on regional government expenditure by program. Together, these responses to increases in unconditional and conditional grants indicate shifts in regional government expenditure between programs as one federal grant is substituted by another. These shifts in program expenditures give rise to variations in local and spill-over income effects of federal grants. In the next section, the structure of the Basic I-O model employed in the empirical analysis of federal grants is described.

6.3 The Basic Interregional Input-Output Model

In this section, the Basic interregional I-0 model of the Canadian economy is presented. The data employed in this model are limited and are drawn from many varied sources. Much of the data which is required to empirically implement the theoretical I-0 model of Chapter 5 is not available. Moreover, the data which are available are often incompatible or non-conformable for use in an I-0 model similar to that presented in Chapter 5. For example, the data for the intermediate demand, personal consumption final demand, and other final demand sectors of the empirical I-0 model are not conformable with the data for the regional government final demand sector of the model. The data for the first three sectors are obtained from the AERC I-0 table (Appleton, 1973) and are available only at a 24 industry Standard Industrial Classification (SIC) level. In contrast, the data for regional government final demand obtained from Kubursi (1978, Chapter 4) are available only at a 49 industry SIC level. This conformability problem is surmounted by aggregating all sectors to a common 16 industry SIC base. Because of problems of this nature, much of the discussion in this section focuses on the adjustments which are required to make the data conformable for application to I-0 models. Thus, the empirical Basic I-0 model differs necessarily from the theoretical Basic I-0 model. These differences are reflected primarily in the degree of complexity of the model.

The empirical Basic I-0 model is presented mathematically and described in Section 6.3.1. This presentation provides a format in which each of four components of the model is discussed. The four components are: the intermediate demand sector, personal consumption final demand, regional government final demand, and other final demand. The discussion of each of these components is presented in Sections 6.3.2 through 6.3.5 respectively.

6.3.1 The Structure of the Basic Interregional I-O Model

In this section, the structure of the empirical Basic I-O model is discussed. This discussion highlights the differences between the theoretical Basic I-O model and the empirical Basic I-O model.

Consider a mathematical statement of the empirical Basic I-O model. The Basic model is a static, open Leontief system which is defined over 16 industries in 5 regions. In this model, marginal input and consumption coefficients equal their average values. Furthermore, there is no possibility of substitution between production processes, and it is assumed that all interregional trade coefficients are constant. In addition, changes in any one component of final demand are assumed to have no effect on other final demand components unless otherwise specified.

The model is summarized in the familiar accounting balance equation which states that the value of total production must equal the total value of local and foreign demand for intermediate and final uses. In matrix-vector notation, this balance equation is

$$(6.5) \qquad \underline{X} = \underline{\underline{T}}\,\underline{\underline{\hat{A}}}\,\underline{X} + \underline{\underline{T}}[\underline{\underline{\hat{C}}}\underline{c} + \underline{\underline{\hat{F}}}\underline{f}] + \underline{\underline{T}}\,\underline{\underline{\hat{G}}}[\underline{\underline{\hat{H}}}_1 g_1 + \underline{\underline{\hat{H}}}'_2 g_2]$$

where

$\underline{X}$ is an 80 x 1 column vector representing the value of output in each of the 16 industries in each region;

$\underline{\underline{T}}$ is an 80 x 80 matrix of 25 sets of 16 x 16 diagonal matrices of trade coefficients, $\hat{\underline{\underline{T}}}^{rk}$. Each $\hat{\underline{\underline{T}}}^{rk}$ matrix has diagonal elements, t_i^{rk}, i=1,...,16, which represent the flow of output of industry i from region r to region k per dollar of output of industry i demanded in region k;

$\hat{\underline{\underline{A}}}$ is an 80 x 80 block diagonal matrix of fixed technology coefficients. Each block on the diagonal, $\underline{\underline{A}}^k$, k=1,...5, is a 16 x 16 matrix of technical production coefficients for industries located in one region;

$\hat{\underline{\underline{C}}}$ is an 80 x 5 block diagonal matrix of personal average propensities to consume. Each matrix on the diagonal, $\underline{C}^k$, k=1,...,5, is a 16 x 1 column vector of average consumption coefficients of households in a region;

$\underline{c}$ is a 5 x 1 column vector of the value of consumption in each region;

$\hat{\underline{\underline{F}}}$ is an 80 x 5 block diagonal matrix of other final demand coefficients. Each block on the diagonal, $\underline{F}^k$, k=1,...,5, is a 16 x 1 column vector of other final demand coefficients for each industry in each region;

$\underline{f}$ is a 5 x 1 column vector of the value of other final demands in each region;

$\hat{\underline{\underline{G}}}$ is an 80 x 25 block diagonal matrix of regional government final demand coefficients. Each block on the diagonal, $\underline{\underline{G}}^k$, is a 16 x 5 matrix of final demand coefficients for each industry by each of five regional government programs, i.e., health, social welfare, etc., in each region;

$\hat{\underline{\underline{H}}}_1$ is a 25 x 5 block diagonal matrix representing each regional government's allocation of own revenue and unconditional grants to the five programs. Each block on the diagonal $\underline{H}_1^k$ is a 5 x 1 column vector of fiscal response coefficients in each region;

$\underline{g}_1$ is a 5 x 1 column vector of the value of own revenue and unconditional grants in each region;

$\hat{\underline{\underline{H}}}_2'$ is a 25 x 15 block diagonal matrix representing each regional government's allocation of three conditional grants to the five programs. Each block on the diagonal, $\underline{\underline{H}}_2^{k'}$, is a 5 x 3 matrix of conditional grant allocation coefficients in each region;

$\underline{g}_2$ is a 15 x 1 column vector of the value of three conditional grants to each region.

For ease of reference, these matrices and others required in development of the Basic I-O model are presented schematically in Figure 6.1. Here, all letters in brackets, ( ), indicate values rather than coefficients.

Next consider payments to labour as a primary input. This payment to labour, total wage value-added, is demand determined as the supply of labour is considered to be infinitely elastic at the existing wage rate. The demand for labour in each industry is represented in the system of equations summarized in equation (6.6),

$$(6.6) \qquad \underline{Y}^+ = \hat{\underline{\underline{V}}}_x^+ \underline{X}$$

where

$\underline{Y}^{+}$ is an 80 x 1 column vector of employment income accruing in each industry in each region; and

$\hat{\underline{\underline{V}}}_{x}^{+}$ is an 80 x 80 diagonal matrix of wage value-added coefficients in the production sector of the economy.

Within each region, labour is demanded by producers, consumers, other final demands, and regional governments. Thus, the total demand for labour in each region is represented by the system of equations summarized in equation (6.7),

$$(6.7) \qquad \underline{Y} = \hat{\underline{\underline{V}}}_{x} \, \underline{X} + \hat{\underline{\underline{V}}}_{N}\underline{c} + \hat{\underline{\underline{K}}}\underline{f} + \hat{\underline{\underline{V}}}_{G}(\hat{\underline{\underline{H}}}_{1}\underline{g}_{1} + \hat{\underline{\underline{H}}}_{2}'\underline{g}_{2}),$$

where

$$(6.8) \qquad \hat{\underline{\underline{V}}}_{x} = \hat{\underline{\underline{\Pi}}} \, \hat{\underline{\underline{V}}}_{x}^{+}.$$

Here,

$\underline{Y}$ is a 5 x 1 column vector of total employment income in each region;

$\hat{\underline{\underline{V}}}_{x}$ is a 5 x 80 block diagonal matrix of wage value-added coefficients in the production sector of the economy. Each block on the diagonal, $\underline{V}^{k'}$, is a 1 x 16 row vector of wage value-added coefficients for each industry of one region;

$\hat{\underline{\underline{\Pi}}}$ is a 5 x 80 block diagonal "summing" matrix. Each block on the diagonal, $\underline{\Pi}^{k}$, is a 1 x 16 unit row vector;

$\hat{\underline{\underline{V}}}_{N}$ and $\hat{\underline{\underline{K}}}$ are 5 x 5 diagonal matrices of labour input coefficients associated with consumption and other final demand respectively. Each entry on the diagonal of these matrices, w_{c}^{k} and K^{k} respectively, is the labour coefficient associated with consumption or other final demand in each region;

FIGURE 6.1

DISPLAY OF INTERREGIONAL INPUT-OUTPUT MATRICES

	Trade Coefficients: $\hat{T}$	Intermediate Demand: $\hat{A}$	Final Demand: consumption: $\hat{C}$	Final Demand: other: $\hat{F}$	Final Demand: Regional Government final demands: $\hat{G}$	Final Demand: Regional Government unconditional grants: $\hat{H}_1$	Final Demand: Regional Government conditional grants: $\hat{H}_2'$	Total
	16 industries, 5 regions	16 industries, 5 regions						
16 industries 5 regions	$_{1 \ldots 80}\begin{bmatrix} \hat{T}^{11} & \hat{T}^{12} \cdots & \hat{T}^{15} \\ \vdots & \hat{T}^{22} \ddots & \vdots \\ \hat{T}^{51} & \cdots & \hat{T}^{55} \end{bmatrix}^{1 \ldots 80}$	$\begin{bmatrix} A^1 & & 0 \\ & A^2 \ddots & \\ 0 & & A^5 \end{bmatrix}^{1 \ldots 80}$	$\begin{bmatrix} C^1 & & 0 \\ & C^2 \ddots & \\ 0 & & C^5 \end{bmatrix}^{1 \ldots 5}$	$\begin{bmatrix} F^1 & & 0 \\ & F^2 \ddots & \\ 0 & & F^5 \end{bmatrix}^{1 \ldots 5}$	$\begin{bmatrix} G^1 & & 0 \\ & G^2 \ddots & \\ 0 & & G^5 \end{bmatrix}^{1 \ldots 30}$			$\begin{bmatrix} (X) \end{bmatrix}$
Primary Inputs: Labour		$_{1 \ldots 5}\begin{bmatrix} V^{1'} & & 0 \\ & V^{2'} \ddots & \\ 0 & & V^{5'} \end{bmatrix}$	$\begin{bmatrix} w_c^1 & & 0 \\ & w_c^2 \ddots & \\ 0 & & w_c^5 \end{bmatrix}$	$\begin{bmatrix} K^1 & & 0 \\ & K^2 \ddots & \\ 0 & & K^5 \end{bmatrix}$	$\begin{bmatrix} E^{1'} & & 0 \\ & E^{2'} \ddots & \\ 0 & & E^{5'} \end{bmatrix}$			$\begin{bmatrix} (Y) \end{bmatrix}$
Primary Inputs: Government		$_{1 \ldots 5}\begin{bmatrix} P^{1'} & & 0 \\ & P^{2'} \ddots & \\ 0 & & P^{5'} \end{bmatrix}$	$\begin{bmatrix} R^1 & & 0 \\ & R^2 \ddots & \\ 0 & & R^5 \end{bmatrix}$	$\begin{bmatrix} S^1 & & 0 \\ & S^2 \ddots & \\ 0 & & S^5 \end{bmatrix}$				$\begin{bmatrix} (W) \end{bmatrix}$
Regional Government Programs						$_{1 \ldots 30}\begin{bmatrix} H_1^1 & & 0 \\ & H_1^2 \ddots & \\ 0 & & H_1^5 \end{bmatrix}^{1 \ldots 5}$	$\begin{bmatrix} H_2^{1'} & & 0 \\ & H_2^{2'} \ddots & \\ 0 & & H_2^{5'} \end{bmatrix}^{1 \ldots 15}$	
TOTAL		$\begin{bmatrix} (X') \end{bmatrix}$	$\begin{bmatrix} (c') \end{bmatrix}$	$\begin{bmatrix} (f') \end{bmatrix}$		$\begin{bmatrix} (g_1') \end{bmatrix}$	$\begin{bmatrix} (g_2') \end{bmatrix}$	

$\hat{\underline{\underline{V}}}_G$ is a 5 x 25 block diagonal matrix of wage value-added coefficients associated with regional government programs. Each block on the diagonal, $\underline{E}^{k'}$, is a 1 x 5 row vector of labour coefficients associated with each of the five government programs in a region.

This statement of the empirical Basic I-O model indicates that the regional government sector of the theoretical model has been simplified. In specifying the regional government final demand sector of the empirical Basic I-O model, only two types of federal grants are differentiated; unconditional grants and conditional grants. This is in contrast to the theoretical Basic I-O model in which four types of federal grants are differentiated; unconditional grants, conditional non-matching grants, open-ended matching grants, and closed-ended matching grants. This simplification reflects the lack of data for regional government final demand which is disaggregated by sub-program, e.g., diagnostic health services. However, this simplification is consistent with the behavioural model of regional government expenditure which is presented in Section 6.2.

6.3.2 The Intermediate Demand Sector

In this section, the intermediate demand sector of the empirical Basic I-O model is discussed. This sector is summarized in the intermediate demand variable, $\underline{\underline{T}}\ \hat{\underline{\underline{A}}}\ \underline{X}$, of equation (6.5) and in the equation which summarizes employment income accruing in each industry, equation (6.6). Three components of this sector are described: the matrix of technology coefficients, $\hat{\underline{\underline{A}}}$, the matrix of trade coefficients, $\underline{\underline{T}}$, and the primary input matrix, $\hat{\underline{\underline{V}}}^{+}$. Data for each of these matrices are obtained from the AERC interregional I-O table (Appleton, 1973). The nature of the data employed in each of these three components is now discussed. The section is concluded with a comment on the aggregation of industrial sectors which is required to form a common SIC base with the Ontario final demand data.

The Matrix of Technology Coefficients

The matrix of technology coefficients in the Basic interregional I-O model is taken from the AERC interregional I-O table (Appleton, 1973). This technology matrix consists of five regional sectors each of which is formed from a regional I-O table. The five regional I-O tables are:

1. The Atlantic provinces, 1965;
2. Quebec, 1966;
3. Ontario, 1965;
4. Manitoba, 1968; and
5. The United States, 1961.

The three western provinces, Saskatchewan, Alberta, and British Columbia are excluded from the AERC I-O table. Each of these regional I-O tables is now briefly discussed.

The regional I-O table for the Atlantic provinces is a 1965 base Statistics Canada version of the 1960 base I-O table constructed by Kari Levitt for the Atlantic Development Board. This table is a regional I-O table based on the I-O tables of the four Atlantic provinces. The Atlantic provinces' I-O table is disaggregated into 34 industrial sectors (Appleton, 1973, pp. 18-20).

The Quebec I-0 table is an adaptation of the 307 commodity by 74 industrial sector 1966 table constructed by T.I. Matuszewski for the Quebec Bureau of Statistics (Appleton, 1973, pp. 20-21).

The Ontario I-0 table is that developed by the Economic Analysis Branch of the Department of Treasury and Economics, Ontario Government under the direction of R. Frank, S. Batrik, and D. Haronitis. This table is constructed on a 49 industrial sector base, and employs 1965 data (Appleton, 1973, p. 21).

The Manitoba I-0 table is based on the I-0 table developed by M. Cormack and N. Malik of the Manitoba Consultative Board using 1961 data. The updated 1968 Manitoba table prepared by N. Malik forms the Manitoba I-0 table in the AERC interregional table. The Manitoba table consists of 37 industrial sectors (Appleton, 1973, pp. 21-22).

The United States sector of the AERC I-0 table is represented by the 1961 Statistics Canada I-0 table (Appleton, 1973, p. 9).

The data sources employed in constructing the AERC interregional I-0 table are diverse and non-conformable for matrix operations. Thus, each of these regional I-0 tables has been aggregated to a common 24 industry SIC base by the AERC (Appleton, 1973, p. 7). In addition, the base year of most regional I-0 tables employed by the AERC differs. The AERC reasons that production technology did not change significantly between 1965 and 1968. This stability of technology coefficients does not warrant updating each regional I-0 table to a common base year[17] (Appleton, 1973, p. 9).

For the purpose of this study, the AERC I-0 table is considered to be a 1965 base year I-0 table. This treatment of the AERC I-0 table is not expected to alter significantly the conclusions of this research. The I-O tables for Ontario, the most industrialized Canadian region, and the Atlantic provinces are based on 1965 data. In addition, the I-O coefficients describing the Quebec economy are expected to have changed only marginally between 1965 and 1966. To the extent that these coefficients have changed, the results obtained from this model will be biased.

The Matrix of Trade Coefficients

The interregional trade linkages in the Basic I-O model are summarized in the elements of the trade coefficient matrix, $\underline{\underline{T}}$. These trade coefficients for 24 industries in the five regions are obtained from the AERC interregional I-O table. The trade coefficient, t_i^{rk}, which indicates the flow of commodity i from region r to region k is defined in equation (6.9),

$$t_i^{rk} = \frac{\sum_{j=1}^{24} x_{ij}^{rk} + h_i^{rk}}{\sum_{r=1}^{5} \sum_{j=1}^{24} x_{ij}^{rk} + \sum_{r=1}^{5} h_i^{rk}} . \tag{6.9}$$

The numerator in this ratio is the total amount of commodity i which is purchased by all industries and all final demands in region k from region r, $\sum_{j=1}^{24} x_{ij}^{rk}$ and h_i^{rk} respectively. The denominator in this ratio is the total purchase of commodity i by all industries and final demands in region k from all regions.

The advantages of using this formulation are its consistency with published data on interregional commodity flows and its ability to incorporate the cross-hauling of commodities. Alternatively, the disadvantage in using this formulation is that it requires the assumption of uniformity of trading relationships for all industries and all final demands within a region (Reifler, 1973, p. 139).

The trade coefficients in the AERC interregional I-0 table are drawn from many sources. These data sources for each aggregate industrial grouping are described in Appendix C.

The Primary Input Matrix

Inputs which are directly employed by an industry are primary inputs. These inputs constitute the value-added of the industry. The value of intermediate inputs, on the other hand, constitute value-added by other industries (Yan, 1969, p. 100). The Basic I-0 model employed in this study has two primary inputs: wage value-added, e.g., employment income, and value-added by regional and municipal governments. The primary input data are obtained from the AERC I-0 table. In the AERC table, value-added is calculated for each of the 24 industries in each region from the regional I-0 tables and revised, updated regional statistics (Appleton, 1973, p. 11). The conspicuous absence of profit value-added in this model is attributed to the lack of an investment sector in the AERC interregional I-0 table.

In applying the Basic I-0 model to grant-induced regional government expenditure, only employment income is calculated. Thus, the primary input matrices, $\underline{\underline{\hat{V}}}^{+}_{x}$ and $\underline{\underline{\hat{V}}}_{x}$, contain only wage value-added coefficients. Regional and municipal government value-added is retained only to maintain equality between column and row sums, and between total value-added and total final demands in the I-0 table.

Consolidation of the Intermediate Demand Sector

In the introduction to Sections 6.3 and 6.3.2, non-conformability of the AERC I-O table and the Ontario I-O final demand table was discussed. In way of review, this non-conformability stems from a difference in the number of industries included in each I-O table. The AERC I-O table is a 24 industry table while the Ontario government final demand table is presented in a 29 industry format. This conformability problem is accommodated by consolidating each I-O component into a standard SIC base. The consolidation of the intermediate demand sector of the Basic I-O model is now discussed.

The 24 industry AERC intermediate demand matrix, $\underline{\underline{T}}\,\underline{\underline{\hat{A}}}$, and the primary input matrix, $\underline{\underline{\hat{V}}}^{+}_{x}$, are consolidated into 16 industries. The consolidation is performed in three steps. For clarity in exposition, each of these steps is discussed in detail.

First, the consolidation of columns in the I-O table must be performed with value units. For this reason, the I-O table is converted from coefficients to value units. The conversion of I-O coefficients to value units is performed by multiplying each coefficient by the appropriate industry's value of output. This conversion of intermediate demand coefficients and wage value-added coefficients is summarized, in matrix-vector notation, in equations (6.10) and (6.11) respectively,

$$(6.10) \quad \underline{\underline{X}}^{*} = \underline{\underline{T}}\,\underline{\underline{\hat{A}}}\,\underline{\underline{\hat{X}}}$$

and

$$(6.11) \quad \underline{\underline{\hat{V}}}^{*}_{x} = \underline{\underline{\hat{V}}}^{+}_{x}\,\underline{\underline{\hat{X}}}\ ,$$

where

$\underline{\underline{X}}^*$ is an 80 x 80 matrix of intermediate input values, x_{ij}^{rk} ;

$\hat{\underline{\underline{X}}}$ is an 80 x 80 diagonal matrix of the total input values in each industry and region;

$\hat{\underline{\underline{V}}}_x^*$ is an 80 x 80 matrix of the value of wage value-added in each industry.

Second, corresponding elements in each of the rows which are consolidated are summed. For example, a typical element of a new row h which is formed by consolidating rows f and g is described by equation (6.13a),

$$\text{(6.13a)} \qquad x_{ij}^{rk} = \sum_{\ell=f}^{g} x_{\ell j}^{rk} .$$

Similarly, corresponding elements in each of the columns which are consolidated are summed. Consistent with the previous example, the new column h is formed from columns f and g. A typical element of this consolidated column is described in equation (6.13b),

$$\text{(6.13b)} \qquad x_{ih}^{rk} = \sum_{\ell=f}^{g} x_{i\ell}^{rk} .$$

The new diagonal elements of the consolidated matrix are equal to the sum of all constituent elements which are common to both the consolidated rows and columns. For example, the new diagonal element from the consolidation of rows f and g, and columns f and g is described by equation (6.14),

$$(6.14) \qquad x_{hh}^{rk} = \sum_{i=f}^{g} \sum_{j=f}^{g} x_{ij}^{rk} .$$

As the intraindustry items in the AERC I-O table are not netted out, there is no difficulty connected with the definition of the new diagonal elements, e.g., x_{hh}^{rk}. For ease of reference, a schematic representation of this consolidation is presented in Figure 6.2. The intermediate demand sector of the I-O table is positioned in the upper left-hand corner of this figure.

Third, the technology coefficients, a_{ij}^{rk}, are computed by the usual formulas. The coefficients of the newly-formed rows and columns are described in equations (6.15a) and (6.15b) respectively.

$$(6.15a) \qquad a_{hj}^{rr} = \frac{x_{hj}^{rr}}{X_j^r} = \frac{\sum_{\ell=f}^{g} x_{\ell j}^{rr}}{X_j^r} = \sum_{\ell=f}^{g} a_{\ell i}$$

and

$$(6.15b) \qquad a_{ih}^{rr} = \frac{x_{ih}^{rr}}{X_h^r} = \frac{\sum_{\ell=f}^{g} x_{i\ell}^{rr}}{\sum_{\rho=f}^{g} X_\rho^r} = \sum_{\ell=f}^{g} \frac{x_{i\ell}^{rr}}{X_\ell^r} \frac{X_\ell^r}{\sum_{\rho=f}^{g} X_\rho^r}$$

$$= \sum_{\ell=f}^{g} a_{i\ell}^{rr} \gamma_\ell^r .$$

Equation (6.15a) states that the composite industry, h, supplies to other industries the simple sum of what its constituents, f and g, supplied. Alternatively, equation (6.15b) states that the input requirements of the new composite industry, h, which are summarized in the a_{ih}^{rr}

FIGURE 6.2

SCHEMATIC REPRESENTATION OF THE CONSOLIDATED INTERREGIONAL I-O TABLE

		Consuming Industries 1 … j … f	(f … g)	g . . . 80	Personal Consumption	Regional Government	Other Final Demand	Total Demand
Producing Industries	1 … i … f	x_{ij}^{rr} *	$x_{ih}^{rr} = x_{if}^{rr} + x_{ig}^{rr}$	x_{ij}^{rk} *	*	*	*	X_i^r *
	f … g	$x_{hj}^{rr} = x_{fj}^{rr} + x_{gj}^{rr}$	$x_{hh}^{rr} = x_{ff}^{rr} + x_{fg}^{rr} + x_{gf}^{rr} + x_{gg}^{rr}$	$x_{hj}^{rk} = x_{fj}^{rk} + x_{gj}^{rk}$	$c_h^r = c_f^r + c_g^r$	$g_h^r = g_f^r + g_g^r$	$f_h^r = f_f^r + f_g^r$	$X_h^r = X_f^r + X_g^r$
	g . . . 80	x_{ij}^{kr} *	$x_{ih}^{kr} = x_{if}^{kr} + x_{ig}^{kr}$	x_{ij}^{kk} *	*	*	*	X_i^k *
Labour Value-Added	1 . . . 5	*	$w_h^r = w_f^r + w_g^r$	*	*	*	*	*
Regional-Municipal Government Value-Added	1 . . . 5	*	$\tau_h^r = \tau_f^r + \tau_g^r$	*	*	*	*	*
Total Outlay		X_j^r *	$X_h^r = X_f^r + X_g^r$	X_j^k *	*	*	*	*

*Indicates elements which are unchanged in the consolidation.

Based on Dorfman, Samuelson, and Solow, (1958, p. 241).

TABLE 6.2

INPUT-OUTPUT SECTOR NUMBERS AND STANDARD INDUSTRIAL CLASSIFICATION INDEX OF CONSOLIDATED INPUT-OUTPUT SECTORS

I-O SECTOR NO. OF THIS STUDY	GENERAL DESCRIPTION OF I-O SECTOR	I-O SECTOR NO. OF AERC I-O TABLE	SECTOR NO. OF ONTARIO I-O TABLE	STANDARD INDUSTRIAL CLASSIFICATION NO*
1	Agriculture, Forestry, Fishing, Fur	1, 2, 3	1	011, 013, 015, 017, 019, 021, 031, 039, 041, 045, 047
2	Metallic Ores Non-Metallic Minerals, Fuels, Coal	4, 5, 6	2	051, 052, 053, 054, 055, 056, 057, 058, 059, 061, 063, 065 066, 071, 073, 077, 079, 083, 087, 092, 096
3	Food, Tobacco	7	3, 4, 5, 6, 7, 8, 9, 10, 11	101, 103, 105, 107, 111, 112, 123, 124, 125, 128, 129, 131, 133, 135, 139, 141, 143, 145, 147, 151, 153
4	Rubber, Chemicals	8	12, 40, 41, 42, 43	161, 163, 169, 371, 372, 373, 374, 375, 376, 377, 378, 379
5	Leather, Textiles	9	13, 14, 15, 16, 17, 18	172, 174, 175, 179, 183, 193, 197, 201, 211, 212, 213, 214, 215, 216, 218, 219, 221, 223, 229, 231, 239, 243, 244, 245, 246, 247, 248, 249
6	Wood, Furniture	10	19, 20, 21	251, 252, 254, 256, 258, 259, 261, 264, 266, 268
7	Pulp, Paper	11	22, 23	271, 272, 273, 274,
8	Printing, Miscellaneous Manufacturing	12	24, 44	282, 286, 278, 288, 289, 381, 382, 384, 385, 393, 395, 397, 399
9	Primary Metals	13	25, 26	291, 292, 294, 295, 296, 297, 298
10	Fabricated Metal Products, Machinery	14, 15	27, 28, 29, 30	301, 302, 303, 304, 305, 306, 307, 308, 309, 311, 315, 318, 316
11	Transportation Equipment	16	31, 32	321, 323, 324, 325, 326, 327, 328, 329
12	Electrical Equipment	17	33, 34, 35, 36	331, 332, 334, 335, 336, 337, 338, 339
13	Non-Metallic Mineral Products	18	37, 38	341, 343, 345, 347, 348, 351, 352, 353, 354, 355, 356, 357, 359
14	Petroleum Products	19	39	365, 369
15	Construction	20	45	404, 406, 409, 421
16	Tertiary	21, 22 23, 24	46, 47, 48	501, 502, 504, 505, 506, 507, 508, 509, 512, 515, 516, 517, 519, 524, 527, 543, 544, 545, 548, 572, 574, 576, 579, 602, 604, 606, 608, 611, 613, 614, 615, 616, 617, 618, 619, 621, 622, 623, 624, 625, 626, 627, 629, 631, 642, 647, 649, 652, 654, 656, 658, 663, 665, 667, 669, 673, 676, 678, 681, 691, 692, 695, 697, 698, 699, 702, 704, 731, 735, 737, 801, 803, 805, 807, 809, 821, 823, 825, 827, 828, 831, 851, 853, 859, 861, 862, 864, 866, 869, 871, 872, 873, 874, 875, 876, 877, 878, 879, 891, 893, 894, 896, 897, 899.

*Statistics Canada 1960

coefficient, are a weighted average of the input requirements of its constituent parts, f, and g. The weights, γ_{ℓ}^{r}, $\ell = f, \ldots, g$, are the proportionate importance of each constituent industry's production in the composite industry's production, $X_{\ell}^{r} / \sum_{P=f}^{g} X_{P}^{r}$ (Dorfman, Samuelson, and Solow, 1958, pp. 241-242).

The consolidation of the AERC interregional I-0 table may initiate errors in the empirical analysis of federal grants when the consolidated I-0 model is employed. The origin of this error is the new technical coefficients, a_{ih}^{rr}, which are not invariant constants. The value of the new consolidated coefficient a_{ih}^{rr} is dependent upon the product mix of the new consolidated industry. When this product mix is altered, the technical coefficient of the aggregate industry is also altered. The product mix of the new consolidated industry is summarized in the weights, γ_{ℓ}^{r}, of equation (6.15b). The variation in the aggregate coefficient is minimized if all of the constituent industries:

1. have similar technical coefficients, or
2. invariably change their production levels in about the same proportion so that the weights, γ_{ℓ}^{r}, remain constant.[18] (Dorfman, Samuelson, and Solow, 1958, pp. 242-243.)

The first of these conditions implies that the input requirements of all of the constituent industries are similar. The second condition implies that the output of all constituent industries is required in approximately the same proportion by other industries. The extent to which either of these two conditions is met dictates the degree of error which is introduced into the empirical analysis of federal grants presented in Chapter 7. This error is the direct result of consolidating I-0 industries.

In addition to consolidating industries in the technical coefficient matrix, the primary input matrices must also be consolidated. The consolidation of wage value-added, and regional and municipal government value-added is required to conformability of the I-0 matrices. The consolidation of these value-added matrices is performed according to the same procedures outlined for columns of the technical coefficient matrix, equation (6.15b). For ease of reference, the consolidated value-added coefficients are presented schematically in Figure 6.2. As in the case of the consolidated technical coefficients, the new value-added coefficients will exhibit some variation unless one of the two sufficient conditions is satisfied. Thus, the consolidation of value-added coefficients is analogous to the consolidation of the technical coefficients.

The consolidation of the AERC interregional I-0 table is necessary to operationalize the Basic I-0 model of grant-induced regional government fiscal policy. In an attempt to avoid the introduction of errors through aggregation, the number of consolidated industries is minimized.

The Basic I-0 table obtained by consolidating the AERC interregional I-0 table is described in Table 6.2. In this table, columns 1 and 2 list the new I-0 industry numbers, and a brief description of the 16 industries in the consolidated I-0 table respectively. All five regions in the interregional I-0 table contain the same 16 industries. In column 3, the constituent industries in each new industry are listed. The numbers in this column refer to the industry numbers of the AERC

I-0 table. Thirteen industries in each region of the AERC I-0 table are combined to form four consolidated industries in each region of the new I-0 table. These four new industries are the agriculture, forestry, fishing, and fur industry; the metallic ores, non-metallic minerals, fuels, and coal industry; the fabricated metal products and machinery industry; and the tertiary industry. In addition, the industrial composition of each industry in the consolidated I-0 table is presented in column 5 of Table 6.2. This description of each industry is summarized in three digit SIC indices.

In this section, I-0 data on the interindustry commodity flows, the interregional trade coefficients, and wage value-added have been discussed. The data for these three components of the intermediate input sector are obtained from the 24 industry, 5 region AERC I-0 table. In addition, the necessary consolidation of each regional I-0 table in the AERC I-0 table into 16 industries was discussed. The consolidation technique employed has been discussed in detail. Finally, the characteristics of the new I-0 table were discussed. In the next section, the personal consumption final demand sector of the Basic I-0 model will be discussed.

6.3.3 Personal Consumption Sector

The personal consumption sector of the interregional I-0 model describes the consumption patterns of households in each region. In this section, the algebraic formulation and data sources for this sector of the empirical Basic I-0 model are discussed. In addition, the consistency of these algebraic formulations with the consumption sector developed in the theoretical I-O model is considered. The personal consumption sector of the empirical Basic I-O model consists of three components; the consumption of produced output component, $T \hat{\underline{\underline{C}}} \underline{c}$, the direct consumption of labour services, $\hat{\underline{\underline{V}}}_N$, and the direct consumption of regional and municipal government services, $\hat{\underline{\underline{R}}}$. Each of these components is now discussed.

The Consumption of Produced Outputs

The consumption of produced output component of the interregional I-O model consists of two elements; the matrix of personal consumption coefficients, $\underline{\underline{T}}\, \hat{\underline{\underline{C}}}$, and the column vector of personal consumption values, $\underline{c}$. The characteristics of each of these elements and the data sources employed in constructing each of these elements are now discussed.

Consider the matrix of personal consumption coefficients. Elements of the $\underline{\underline{T}}\, \hat{\underline{\underline{C}}}$ matrix, c_i^{rk}, i = 1,...,24, summarize the "product mix" of total personal consumption by households in each region. The consumption coefficients for households in region k are described by equation (6.16),

$$(6.16) \qquad c_i^{rk} = \frac{C_i^{rk}}{\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}} \quad , \qquad i=1,\ldots,24,$$

where C_i^{rk} is the value of commodity i which is produced in region r and consumed in region k. The 25th and 26th elements in the denominator, $\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}$, are household direct consumption of labour and government services, respectively. These coefficients identify both the regional and industrial origin of consumer purchases. Both of these pieces of information are essential to the empirical interregional I-O model. The consumption coefficient data are obtained from the AERC I-O table.

Second, consider the personal consumption vector, c. Elements of this vector, C^k, k = 1,...,5, summarize the total value of personal consumption in each region. Each C^k, k = 1,...,5, element is formed from the product of:

1. the average propensity to consume out of personal disposable income in the region,
2. personal disposable income in the region, and
3. personal income in the region.

The formulation is described in equation (6.17),

$$(6.17) \qquad C^k = \frac{\sum_{r=1}^{5}\sum_{j=1}^{26} C_j^{rk}}{\nu_d^k} \frac{\nu_d^k}{\nu^k} \nu^k = \frac{\sum_{r=1}^{5}\sum_{j=1}^{26} C_j^{rk}}{\nu^k} \nu^k, \; k=1,\dots,5,$$

where ν_d^k is the personal disposable income in region k and ν^k is personal income in the region. This definition of C^k is consistent with the theoretical I-O model. Data for the average propensity to consume out of personal disposable income are obtained from Gillen and Guccione (1970). Data for total personal consumption are available from the AERC I-O model. Data on personal income and personal disposable income are available from Statistics Canada (National Accounts Income and Expenditure, 1967).

The origin of data for the personal consumption final demand sector indicates that it is not conformable with other sectors of the

Basic I-O model. As in the case of intermediate demands, this final demand sector must be consolidated. This consolidation involves the consolidation of constituent elements as described in equation (6.15a) in Section 6.3.2. For this purpose, the personal consumption sector is expressed in value units. Expressing personal consumption in value units involves post multiplying the 120 x 5 consumption coefficient, $\underline{\underline{T}}\,\hat{\underline{\underline{C}}}$, by the 5 x 1 personal consumption column vector, $\underline{c}$. This new consumption vector, $\underline{\underline{T}}\,\hat{\underline{\underline{C}}}\,c$, is a 120 x 1 column vector of personal consumption values. The elements of this vector indicate the total value of commodity i, i=1,...,24, consumed by households in each region k, k=1,...,5. The consolidation of the personal consumption vector is schematically displayed in the personal consumption column of Figure 6.2. The industries consolidated in each region are the same industries consolidated in the intermediate input sector. The vector of personal consumption expenditure on produced output is consolidated to an 80 x 1 column vector. Consumption in each region k, k=1,...,5, is defined over 16 industries. In the next section, the direct personal consumption of labour, and regional and municipal government services are discussed.

The Consumption of Primary Inputs

Two primary inputs are consumed directly by households: labour services, and regional and municipal government services. These two services constitute the value-added component of personal consumption. In addition, the wage value-added component contributes to employment income. The algebraic form and data source of each of these components are discussed in this section.

First, consider the direct labour component of personal consumption as formulated in the 24 industry and two primary input AERC I-O table. This direct consumption of labour is summarized in the $\hat{\underline{\underline{V}}}_N$ matrix which is schematically displayed in Figure 6.1. Each element in this matrix, w_c^k, k = 1,...,5, summarizes the direct labour component of personal consumption in each region k, k = 1,...,5. These coefficients are defined in equation (6.18),

$$(6.18) \qquad w_c^k = \frac{W_c^k}{\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}} \quad , \; k = 1,\ldots,5,$$

where W_c^k is the value directly consumed by households in region k.

In the calculation of employment income in each region, the direct labour component of personal consumption must be expressed in value terms. This direct consumption of labour by the personal consumption sector is expressed in value units by forming the product of the $\hat{\underline{\underline{V}}}_N$ coefficient matrix and the $\underline{c}$ total value of consumption vector. Elements of the 5 x 1 column vector formed by this product, $\hat{\underline{\underline{V}}}_N \, \underline{c}$, are defined in equation (6.19),

$$(6.19) \qquad w_c^k C^k = \left[\frac{W_c^k}{\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}} \right] \frac{\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}}{\nu^k} \, \nu^k = \frac{W_c^k}{\nu^k} \, , \; k = 1,\ldots,5.$$

This definition of the direct labour component in personal consumption (the wage value-added) is analogous to the definition of the personal consumption of commodities described in the previous section.

The specific formulation of wage value-added in personal consumption which is presented in equation (6.19) is chosen because of its consistency with the equation for personal income in the theoretical I-O model. Personal income is defined in equation (5.31) of Section 5.5.2, Chapter 5. In equation (5.29) personal income earned in the consumption sector of region k, k = 1,...,5, is summarized in the $(b_s^k)\nu^k$ variable. b_s^k is defined, in equation (5.30c), as the average propensity of households to directly consume labour services,

$$(6.20) \qquad b_s^k = \frac{w_c^k}{\nu^k} .$$

The data for the wage value-added coefficients w_c^k, k = 1,...,5, are derived from the AERC I-O table and the National Accounts published by Statistics Canada (1967, No. 13, 201).

Second, consider the direct consumption of regional and municipal government services. These consumption variables are summarized in the $\hat{\underline{\underline{R}}}$ matrix which is presented schematically in Figure 6.1. Each element in this matrix, R^k, is defined as the proportion of total personal consumption which is made up of government services. This definition of the government value-added coefficients is summarized in equation (6.21),

$$(6.21) \qquad R^k = \frac{R*^k}{\sum_{r=1}^{5} \sum_{j=1}^{26} C_j^{rk}} , \qquad k = 1,...,5.$$

In this equation, R^{*k} represents the value of the consumption of regional and municipal government services by households in region k.

The data for the government value-added coefficients which are defined in equation (6.21) are obtained from the AERC I-O table.

The wage value-added, and regional and municipal government value-added components of the personal consumption sector are presented in an aggregate regional format. Thus, these two components of the interregional I-O model do not require consolidation.

This concludes the presentation of the personal consumption sector. Two components of personal consumption were explicitly discussed: the consumption of commodities by households, and the consumption of primary inputs by households. For each component, the algebraic formulation and data source were presented. In addition, considerable attention was placed on emphasizing the consistency of the formulation employed here and the formulation in the theoretical model. In the next section, regional government final demands are discussed.

6.3.4 The Regional Government Sector

The regional government sector of the Basic I-O model summarizes the demand by regional governments for produced and primary inputs. As in the theoretical Basic I-O model, the specification of regional government final demand presented in this empirical I-O model emphasizes the regional government expenditure which is induced by federal grants. However, the specification of regional government final demand in the empirical model is much simpler than that of the theoretical model. In the empirical model, only two types of federal grants are considered; unconditional grants, and conditional grants. Thus, the regional government sector as represented in equation (6.5), $\hat{\underline{\underline{T}}}\ \hat{\underline{\underline{G}}}[\hat{\underline{\underline{H}}}_1\underline{g}_1 + \hat{\underline{\underline{H}}}_2'\underline{g}_2]$, has only four components:

1. the final demand coefficient matrix, $\hat{\underline{\underline{G}}}$,
2. the interregional trade coefficient matrix, $\hat{\underline{\underline{T}}}$,
3. the fiscal response matrices, $\hat{\underline{\underline{H}}}_1$ and $\hat{\underline{\underline{H}}}_2'$, and
4. the federal grant vectors, $\underline{g}_1$ and $\underline{g}_2$.

In this section, each of these components is discussed. In this discussion, particular attention is given to two items: (1) the empirical formulation of regional government final demand coefficients, and (2) the consolidation of the final demand coefficient matrix and trade coefficient matrix. In addition, the source of data for each component is presented.

The Final Demand Coefficient Matrix

Consider the algebraic formulation and data sources for the regional government final demand matrix, $\hat{\underline{\underline{G}}}$. Elements of this matrix, g_{iJ}^k, summarize the demand by a regional government for the output of each industry as expenditure on a program is increased by one dollar. This final demand coefficient is defined in equation (6.22),

$$(6.22) \qquad g_{iJ}^k = \frac{E_{iJ}^k}{E_J^k}\ , \qquad k = 1,\ldots,5, \quad i = 1,\ldots,16, \quad J = 1,\ldots,5,$$

where E^k_{iJ} is the value of final demand by regional government k for the output from industry i which is to be used in the provision of program J; and

E^k_J is the total expenditure by the regional government on program J.

Thus, the definition of this coefficient is similar to all other I-O coefficients.

The regional government final demand coefficients are constructed using data from two sources:

1. 1965 program final demand coefficients for the government of Ontario (Kubursi, 1978, Chapter 4), and
2. total wage and non-wage, i.e., produced inputs, expenditure on each regional government program (Statistics Canada, No. 68-207).

The Ontario final demand data are used as the basis for all regional government final demands because the required data on regional government program expenditure by industry, i.e., E^k_{iJ}, are not available at this time. The Ontario government program final demand vectors are available at a 49 industry level of aggregation. Thus, for conformability with other sectors of the empirical model the initial step in using the Ontario data is to consolidate each 49 industry Ontario final demand vector into a 16 industry vector. All industries except four are consolidated to form new industries. The groupings of constituent Ontario industries included in each new industry are presented in column 4 of Table 6.2. The SIC index for constituent industries of each new industry is presented in column 5 of the same table.

In employing the Ontario government final demand data, it is assumed that all regional governments use the same relative amount of each produced input in the provision of a program as does the Ontario government. For example, the expenditure on input i used to produce program J, E^k_{iJ}, relative to the total expenditure on produced inputs for this program E^k_{cJ}, is constant across all regions k = 1,...,5. This assumption is expressed in the definition of the produced input coefficient g^{+k}_{iJ} in equation (6.23a),

$$(6.23a) \qquad g^{+k}_{iJ} = g^{+o}_{iJ} = \frac{E^o_{iJ}}{E^o_{cJ}} \quad ,$$

where

$$(6.23b) \qquad E^o_{cJ} = \sum_{i=1}^{16} E^o_{iJ}$$

and superscript o denotes Ontario. Dividing both the numerator and the denominator of the right-hand side of equation (6.23a) by total program expenditure, E^o_J, the produced input coefficient is seen to be the ratio of the Ontario final demand coefficient for program J, g^o_{iJ}, to the sum of the Ontario final demand coefficients for program J, g^o_{cJ},

$$(6.24a) \qquad g^{+k}_{iJ} = g^{+o}_{iJ} = \frac{\dfrac{E^o_{iJ}}{E^o_J}}{\dfrac{E^o_{cJ}}{E^o_j}} = \frac{g^o_{iJ}}{g^o_{cJ}}$$

where

$$(6.24b) \qquad g^{o}_{cJ} = \sum_{i=1}^{16} g^{o}_{iJ} \quad .$$

These coefficients allocate the total program expenditure on produced inputs, E^{k}_{cJ}, between individual industries.

The final demand coefficients presented in equation (6.22) are now defined in terms of the available data. These coefficients are derived from the formulation presented in equation (6.25a),

$$(6.25a) \qquad g^{k}_{iJ} = g^{+k}_{iJ} \frac{E^{k}_{cJ}}{E^{k}_{J}} = g^{+k}_{iJ} \, g^{k}_{cJ} \, , \qquad \begin{array}{l} k = 1,\ldots,5, \\ J = 1,\ldots,5, \\ i = 1,\ldots,16, \end{array}$$

where

$$(6.25b) \qquad g^{k}_{cJ} = \frac{E^{k}_{cJ}}{E^{k}_{J}}$$

is the proportion of total program expenditure, E^{k}_{J}, on produced inputs, E^{k}_{cJ}. This formulation of final demand coefficients allocates the total program expenditure by regional governments between industries.

In applying data to the formulation of final demand coefficients in equation (6.25a), a difficulty arises in constructing the empirical Basic I-O model. The nature of this difficulty is that the observed g^{k}_{cJ} coefficients are not constant through time. Variation in the g^{k}_{cJ} coefficients is tranmitted to the final demand coefficients as seen in equation (6.25a). This variation in final demand indicates that the empirical analysis will be in error if the final demand coefficients derived from the g^k_{cJ} of a given period are used to analyze regional government expenditure for a period when the proportion of expenditure on produced outputs to total expenditure, g^k_{cJ}, has changed.

The variation in g^k_{cJ} is attributed partially to regional government expenditure on capital projects which are capital intensive relative to current expenditure projects. In addition, it is possible that each capital expenditure project has a unique produced input expenditure to total program expenditure ratio, E^k_{cJ}/E^k_J . Thus, as a capital project is initiated, the proportion of produced input expenditure to total program expenditure, is reduced. Over time, as capital projects are completed and are (or are not) replaced with new capital projects, the g^k_{cJ} and g^k_{iJ} coefficients will fluctuate.

As the final demand coefficients are intended to describe the input requirements of a "standard" regional government program, the systematic reduction of the temporal variation in regional government final demand coefficients is necessary. In addition, the standardization of each regional government program is important because the data contained in the AERC interregional I-O table span several years, 1961 to 1968. The standardized final demand data provide input coefficients which are representative of the time period from which the AERC data are drawn.

The input requirements of providing a "standard" regional government program are most accurately described when the cyclical capital component of total program expenditure is eliminated. Following Stone and Brown (1962, pp. 78-80), it is assumed that the capital project cycle and the accompanying capital expenditure are three years in duration. Thus, the trend value of regional government expenditure; for example, current expenditure, is obtained by computing a three-year moving average of the observed E^k_{cJ}/E^k_J ratios for all regions and programs. The time period over which the averages are calculated is 1961 through 1969. The substitution of the average value corresponding to 1965 in equation (6.25a) for g^k_{cJ} eliminates the cyclical variation which is observed in the final demand coefficients.

The formulation of regional government final demand presented in this section is consistent with both the theoretical Basic I-O model developed in Chapter 5 and the available data on regional government expenditure. The formulation discussed in this section does not explicitly show the direct interregional flow of commodities which is required to satisfy regional government final demands. In the next section, the trade coefficient matrix, $\underline{\underline{T}}$, which provides this information is discussed.

The Trade Coefficient Matrix

The trade coefficient matrix, $\underline{\underline{T}}$, provides information on the interregional flow of commodities. When this information is applied to the regional government final demand coefficient matrix, $\underline{\underline{T}}\,\underline{\underline{\hat{G}}}$, the direct import requirements per dollar of regional government program expenditure are obtained. As discussed in Section 6.3.1, the trade coefficient matrix is defined over 24 industries in each region. Alternatively, the regional government final demand matrix, $\underline{\underline{\hat{G}}}$, is defined over 49 industries in each region. The non-conformability of these matrices is obvious. Thus, each matrix must be consolidated independently of the other. In this section, the consolidation of the 24 industry trade coefficient matrix into a 16 industry matrix is discussed.

The method of consolidating the trade coefficient matrix is similar to the procedure employed in the consolidation of other components of the I-O model. However, in this case a specific trade coefficient matrix is derived for each regional government program. Thus, five new trade coefficient matrices are derived. For example, the new trade coefficient matrix for health program final demands is different from the new trade coefficient matrix for education program final demands. Each new trade coefficient matrix reflects the unique industrial composition of each regional government program final demand. The new trade coefficients in each matrix are formed from the weighted sum of the constituent trade coefficients. The weight assigned to each constituent trade coefficient, t_{iJ}^{rk}, $i = 1,\ldots,24$, $J = 1,\ldots,5$, is the relative importance of the same industry, i, in the same program final demand vector, J, reported in the 1966 Canadian I-O table.[19] (Statistics Canada, No. 15-505E.) This method of consolidating the trade coefficient matrix preserves the unique pattern of final demand which is generated by each regional government expenditure program.

The Primary Input Matrix

In the empirical formulation of regional government final demand, wage value-added is the only primary input demanded by regional governments. This demand for labour services is summarized in the $\hat{\underline{\underline{V}}}_G$ matrix. The algebraic formulation of this final demand for labour and the data source for this component of the empirical Basic I-O model are now discussed.

Elements of the $\hat{\underline{\underline{V}}}_G$ matrix summarize the value of regional government expenditure on the labour inputs for a program, $E^k_{\omega J}$, relative to the total expenditure on the program by the regional government, E^k_J. These coefficients of wage value-added in regional government final demand are defined in equation (6.26),

$$(6.26) \qquad g^k_{\omega J} = \frac{E^k_{\omega J}}{E^k_J}, \quad J = 1,\ldots,5, \quad k = 1,\ldots,5.$$

This definition of wage value-added coefficients is consistent with the definition of regional government final demand for produced inputs given in equations (6.25a) and (6.25b). From these three equations, it is clear that the sum of the final demand coefficients for each program and region is unity,

$$(6.27) \qquad 1 = \frac{E^k_{cJ} + E^k_{\omega J}}{E^k_J} = g^k_{cJ} + g^k_{\omega J}, \quad J = 1,\ldots,5, \; k = 1,\ldots,5 .$$

Data on the wage value-added component of regional government program expenditure are obtained from the same source as the data on produced input expenditure (Statistics Canada, No. 68-207). The same cyclical variation which appears in the produced input data is also present in the wage value-added data. This cyclical variation in wage value-added must be removed for the same reasons that it is removed from the produced input data. The procedure for removal of the cyclical variation in the $g^k_{\omega J}$ coefficients is indentical to that which is employed on the g^k_{cJ} coefficients. A three-year moving average of the $E^k_{\omega J}/E^k_J$ data for 1961 through 1969 is calculated. This three-year moving average highlights the trend values of program expenditure which is independent of the three-year capital projects cycle. When the 1965 wage value-added coefficient $g^k_{\omega J}$ is replaced with the 1965 trend coefficient, the influence of the capital project cycle is removed from the regional government final demand matrix. This formulation of wage value-added is consistent with the theoretical I-O model and the data on regional government expenditure for wage value-added.

The Fiscal Response Matrices

In this section, the regional government fiscal response matrices of the empirical Basic I-O model are discussed. Two fiscal response matrices are included in the empirical model; the unconditional grant fiscal response matrix, $\hat{\underline{\underline{H}}}_1$, and the conditional grant fiscal response matrix, $\hat{\underline{\underline{H}}}_2$. These matrices are defined for the four Canadian regions only. First, consider the unconditional grant fiscal response matrix. Elements of this matrix summarize each regional government's fiscal response to federal unconditional grants. The fiscal response is measured by the regional government's change in expenditure on five programs as unconditional grants are increased marginally. This concept of fiscal response is defined in equation (6.28a),

$$(6.28a) \qquad \eta_J^k = \frac{\partial E_J^k}{\partial G_1^k} , \quad J = 1,\ldots,5, \quad k = 1,\ldots,4,$$

where G_1^k is the federal unconditional grant to regional government k. This definition of regional government fiscal response is consistent with the empirical model of fiscal response estimated in Section 6.2. The statistically significant fiscal response coefficients for the five expenditure programs included in the estimated model provide the data on the η_J^k coefficients of the $\hat{\underline{\underline{H}}}_1$ matrix.

Second, consider the conditional grant fiscal response matrix, $\hat{\underline{\underline{H}}}_2'$. Elements of this matrix summarize the fiscal response of regional governments to three federal conditional grants; health, social welfare, and education. As in the case of unconditional grants, fiscal response to conditional grants is measured by the regional government's change in expenditure on five programs as a conditional grant is increased marginally. This definition of fiscal response is summarized in equation (6.28b),

$$(6.28b) \qquad \eta_{KJ}^k = \frac{\partial E_J^k}{\partial G_K^k} , \quad J = 1,\ldots,5, \quad k = 1,\ldots,4,$$

where G_K^k is the federal conditional grant for program K, K = 2,...,4, in region k. Data on the η_{KJ}^k coefficients are available from the estimated regional government fiscal response equations presented in

Section 6.2. The fiscal response coefficients included in $\hat{\underline{\underline{H}}}_2'$ are those which are statistically significant.

The Federal Grant Vectors

Two federal grant vectors are specified in the regional government sector of the empirical model; the unconditional grant vector, $\underline{g}_1$, and the conditional grant vector, $\underline{g}_2$. Each of these vectors summarizes the value of federal grants to the four Canadian regions included in this study. Data on the value of federal grants included in these vectors are obtained from Statistics Canada (No. 68-207).

This concludes the presentation of the regional government sector of the empirical I-O model. The specification of the components of this sector is consistent with the theoretical Basic I-O model and the available data. The major difference between the theoretical Basic I-O model and this empirical Basic I-O model is the specification of the fiscal response matrices. However, this difference is not major. The information contained in the fiscal response matrices is sufficient to analyze the interregional income effects of federal grants. In the next section, the other final demand sector of the empirical model is discussed.

6.3.5 The Other Final Demand Sector

The other final demand sector includes all final demands which are not part of personal consumption and regional government expenditure. In this empirical model, the other final demand sector includes only municipal government expenditure. Investment and inventory changes in each region, and regional exports to the three excluded Canadian provinces and to countries other than the United States are excluded from the other final demand sector of the model. Thus, these final demand sectors are excluded completely from the empirical I-O model. These sectors are excluded because of the lack of data on these final demands in the AERC I-O table. In addition, the primary inputs (value-added) which are associated with each of these excluded sectors are also excluded from the empirical I-O model.

In the empirical Basic I-O model described by equation (6.5), the other final demand sector is summarized in the $\underline{\underline{T}}\ \hat{\underline{\underline{F}}}\ \underline{f}$ matrices and vectors. The other final demand coefficient matrix, $\hat{\underline{\underline{F}}}$, and the vector of other final demand values, $\underline{f}$, and the value-added components of other final demand, $\hat{\underline{\underline{K}}}$ and $\hat{\underline{\underline{S}}}$, are now discussed. In addition the consolidation of the final demand coefficient matrix and the trade coefficient matrix is discussed.

First, consider the other final demand coefficient matrix. This matrix summarizes municipal government expenditure in industry i, i = 1,...,16, per dollar of municipal government expenditure in region k, k = 1,...,5. Elements of the $\hat{\underline{\underline{F}}}$ matrix are defined in equation (6.29),

$$(6.29) \qquad f_i^k = \frac{F_{im}^k}{F_m^k}, \quad i = 1,\ldots,16, \qquad k = 1,\ldots,5,$$

where

F_{im}^{k} is the value of expenditure by municipal governments in region k, on the output of industry i;

F_{m}^{k} is the value of total expenditure by municipal governments in region k.

This definition of other final demand coefficients is consistent with the definitions in other sectors in the empirical Basic I-O model.

The data which are employed in generating these coefficients for the empirical model are obtained from three sources:

1. the regional and municipal government final demand coefficients in the AERC I-O table,
2. the regional government final demand coefficients generated in Section 6.3.4, and
3. Statistics Canada data on total municipal government expenditure in each region (Statistics Canada, No. 68-203).

Other final demand coefficients are constructed initially at a 24 industry level. The formulation employed to generate the other final demand coefficients calculates other final demand as the residual between the AERC regional and municipal government expenditure and regional government expenditure calculated in Section 6.3.4. This formulation is presented in equation (6.30),

$$(6.30) \qquad f_{i}^{k} = \frac{f_{iA}^{k}(F_{m}^{k} + \sum_{J=1}^{5} E_{J}^{k}) - \sum_{J=1}^{5} g_{iJ}^{k} E_{J}^{k}}{F_{m}^{k}} = \frac{F_{im}^{k}}{F_{m}^{k}}, \quad k = 1,..,24,$$

where f_{iA}^{k} is the regional and municipal government final demand coefficient from the AERC I-O table. Consider the two terms in the numerator on the right-hand side of equation (6.30). The first of these terms, $f^k_{iA}(F^k_m + \sum_{J=1}^{5} E^k_J)$, is the value of total expenditure in industry i by regional and municipal governments in region k. Similarly, the second term, $\sum_{J=1}^{5} g^k_{iJ} E^k_J$, is the value of total expenditure in industry i by regional government k. The difference between these two terms is the value of total expenditure in industry i by municipal governments located in region k, F^k_{im}. Thus, the other final demand sector is composed of the residual of the AERC regional and municipal government final demand sector after regional government final demands are netted-out. It is assumed that federal grants to regional governments do not filter down to municipal governments.

Second, consider the value of the other final demands vector, $\underline{f}$. The elements of this vector are the values of total municipal government expenditure in each region during fiscal year 1965, F^k_m. Data on these municipal expenditures are obtained from Statistics Canada (No. 68-205).

The other final demand vector $\underline{\underline{T}}\ \underline{\underline{\hat{F}}}\ \underline{f}$, has been constructed at a 24 industry level of aggregation. Thus, the other final demand vector is a 120 x 1 column vector. For conformability with the other I-O sectors, this final demand sector must be consolidated into 16 industries. The consolidation procedure which is employed here is identical to the procedure discussed in equation (6.15) of Section 6.3.3. For ease of reference, the consolidated rows of the other final demand sector are schematically represented in Figure 6.2. The SIC index for each new industry in the consolidated vector is presented in Table 6.2.

Finally, consider the value-added components in the other final demand sectors. As illustrated in Figure 6.1, there are two value-added components in this sector of the model; wage value-added, and regional and municipal government value-added. These components are represented in the $\hat{\underline{\underline{K}}}$ and $\hat{\underline{\underline{S}}}$ matrices respectively. Each coefficient in the value-added matrices describes the value of primary inputs included in each dollar of other final demand expenditure. Elements of $\hat{\underline{\underline{K}}}$, the wage value-added coefficients in the other final demand sector, f^k_ω, are defined in equation (6.31a),

$$(6.31a) \qquad f^k_\omega = \frac{F^k_{\omega m}}{F^k_m}, \; k = 1,\ldots,5,$$

where $F^k_{\omega m}$ is the value of total expenditure on labour by municipal governments in region k. Similarly, elements of $\hat{\underline{\underline{S}}}$, the regional and municipal government value-added coefficients in other final demand, f^k_g, are defined in equation (6.31b),

$$(6.31b) \qquad f^k_g = \frac{F^k_{gm}}{F^k_m}, \; k = 1,\ldots,5.$$

Here, F^k_{gm} is the value of total expenditure by municipal governments in region k on government services. These definitions in equations (6.31a) and (6.31b) provide a set of value-added coefficients which are consistent with both the theoretical Basic I-O model and the available data. Data on other final demand value-added are obtained from the AERC I-O table.

This completes the presentation of the other final demand sector of the empirical Basic I-O model. In the formulation developed in this section, the other final demand sector is constituted from municipal government final demands in each region.

6.3.6 Conclusion

In this section, the Basic I-O model employed in this study has been described. The model consists of 16 industries in each of 5 regions. Structurally, this model is divided into four sectors; the intermediate demand sector, the personal consumption sector, the regional government sector, and the other final demand sector. The latter three of these sectors are exogenous final demands. Each of the four sectors is composed of several components which were discussed in terms of their algebraic formulation and data sources. In addition, a detailed description of the consolidation procedure which was employed in each sector to standardize the product mix of each industry is presented. The algebraic formulation of most sectors was shown to be consistent with the theoretical Basic I-O model developed in Chapter 5. The notable exception to this consistency is the regional government sector. Data limitations prevent the complete specification of regional government fiscal response to federal grants. However, sufficient detail is retained in the government sector to analyze the interregional income effects of federal grants to regional governments.

In the following section the empirical Keynesian-Leontief I-O model is described.

6.4 The Keynesian-Leontief Interregional I-O Model

In the Basic I-O model described in the previous section, the personal consumption final demand is considered to be an exogenous sector. This treatment of personal consumption is unsatisfactory. The positive relationship between personal consumption and income has long been empirically verified. Thus, the personal disposable income which is derived in the Basic I-O model understates the actual level of personal income induced by an increase in final demands. This inadequacy of the Basic I-O model is discussed in greater detail in Section 5.5 of Chapter 5. In this section, an empirical I-O model which includes personal consumption as an endogenous variable is developed. This model is the Keynesian-Leontief interregional I-O model. The structural form and data sources for the empirical Keynesian-Leontief I-O model are now presented.

Consider the structural form of the Keynesian-Leontief I-O model. Fundamentally, the structure of the Keynesian-Leontief I-O model is similar to that of the Basic I-O model. Four sectors are specified in the model: intermediate demand, personal consumption, regional government, and other final demand. However, unlike the Basic I-O model, both intermediate demand and personal consumption are treated as endogenous variables.

The mathematical formulation of the Keynesian-Leontief I-O model is to treat the personal consumption sector as if it were a producing industry. This treatment of the consumption sector establishes an augmented "producing sector" I-O table for each region.

The augmented regional I-O table has 17 columns and 17 rows. The seventh column in each augmented regional I-O table is the personal consumption coefficient vector for the region, $\underline{C}^k$, k = 1,...,5. Similarly, the seventh row of each augmented regional I-O table is the wage value-added row vector, $\underline{V}^{k'}$, and the wage value-added component of personal consumption,

$$(6.32) \qquad w_c^k = b_s^k \nu^k,$$

for the region, k, k = 1,...,5. This augmented I-O table for region k, k = 1,...,5, is summarized in the 17 x 17 $\underline{\underline{\tilde{D}}}^k$ matrix which is defined in equation (6.33),

$$(6.33) \qquad \underline{\underline{\tilde{D}}}^k = \left[\begin{array}{c|c} \underline{\underline{A}}^k & \underline{C}^k \\ \hline \underline{V}^{k'} & b_s^k \end{array}\right]$$

This matrix forms the basis of the Keynesian-Leontief interregional I-O model.

The description of the structure of the "producing sectors" in the Keynesian-Leontief I-O model implies that the trade coefficient matrix, the government final demand sector, and the other final demand sector must also be augmented by their respective wage value-added components. The mathematical formulation of these augmented components in the empirical Keynesian-Leontief I-O model is equivalent to the formulation of the theoretical Keynesian-Leontief I-O model. This mathematical formulation is presented and discussed in Section 5.5.2 of Chapter 5. The five region Keynesian-Leontief I-O model is summarized in equation (6.34),

$$(6.34) \qquad \underline{\underline{X}}^* = \underline{\underline{T}}^* \hat{\underline{\underline{D}}} \underline{X}^* + \underline{\underline{T}}^* \hat{\underline{\underline{F}}}^* \underline{f} + \underline{\underline{T}}^* \hat{\underline{\underline{G}}}^* (\hat{\underline{\underline{H}}}_1 \underline{g}_1 + \hat{\underline{\underline{H}}}_2 \underline{g}_2),$$

where $\underline{X}^*$ is an 85 x 1 column vector of output and personal disposable income in each region. Every seventeenth element in $\underline{X}^*$ is the value of personal disposable income in a region;

$\underline{\underline{T}}^*$ is an 85 x 85 matrix of 25 sets of 17 trade coefficients. Every seventeenth row and column of $\underline{\underline{T}}^*$ contains the inter-regional labour mobility coefficients. In this model as in the AERC I-O table, labour is assumed to be immobile between regions;

$\hat{\underline{\underline{D}}}$ is an 85 x 85 block diagonal matrix of I-O coefficients. Each block on the diagonal is a 17 x 17 matrix similar to $\tilde{\underline{\underline{D}}}^k$ defined in equation (6.33);

$\hat{\underline{\underline{F}}}^*$ is an 85 x 5 block diagonal matrix of other final demand coefficients. Each block on the diagonal is a 17 x 1 column vector in which the seventeenth element is the coefficient of wage value-added in other final demands, K^k;

$\hat{\underline{\underline{G}}}^*$ is an 85 x 25 block diagonal matrix of regional government final demand coefficients. Each matrix on the diagonal is a 17 x 5 matrix. The elements in the seventeenth row of this diagonal block are the coefficients of wage value-added in each regional government program, g^k_{wJ}, J = 1,...,5.

From equation (6.33), it is seen that the personal consumption sector is totally integrated into the set of endogenous variables of the interregional I-O model.

The data required to implement empirically the Keynesian-Leontief interregional I-O model are readily available. These data are the same data which have been acquired to operationalize the Basic I-O model. In addition, because the data have been previously used in the Basic I-O model all components are conformable. Thus, the problem of consolidating industrial sectors does not arise. Details of the data are discussed in Section 6.3.

The Keynesian-Leontief interregional I-O model presented in this section is more realistic than the Basic I-O model presented in Section 6.3. This increase in realism is obtained by treating personal consumption as an endogenous variable. The inclusion of personal consumption as an endogenous variable complicates the formal statement of the model. However, the data requirements of this formulation are not significantly different from those required to implement the Basic I-O model. The additional data requirements include households' average propensity to directly consume labour services, b_s^k. Empirically implementing the Keynesian-Leontief I-O model is relatively simple.

6.5 Summary

In this chapter, an empirical model of regional government expenditure and two empirical interregional I-O models have been presented. The two I-O models are:

1. the Basic I-O model in which personal consumption is exogenous, and
2. the Keynesian-Leontief I-O model in which personal consumption is endogenous.

These three models represent simplified and empirically operational versions of the theoretical models developed in Chapters 4 and 5. In each model, the allocation of regional government revenue between five expenditure programs is emphasized. The allocation of regional government revenue is induced by federal conditional and unconditional grants to regional governments. The five regional government expenditure programs in the model are: health, social welfare, education, transportation-communication, and other programs. Four Canadian regional governments are represented in the models: the Atlantic provinces, Quebec, Ontario, and Manitoba. In addition, the United States is included in the I-O models.

The model of regional government expenditure is an extremely simple, linear model. This model is not intended to be a complete behavioral explanation of regional government expenditure. Rather, it is estimated for the purpose of obtaining data on the changes in regional government expenditure which are induced by federal grants. These data on grant induced expenditure changes are essential in completing the I-O models. Such estimates are unavailable from other sources.

In employing the model of regional government expenditure, the fiscal response of the four Canadian regions to unconditional grants and five conditional grants is estimated. The five conditional grants are; health, social welfare, education, transportation-communication, and natural resource-primary industry development. Regional government expenditure is disaggregated into the five expenditure programs. The disaggregation of conditional grants and expenditure programs in this model provides detailed information on the grant-induced allocation of regional government expenditure between programs.

The interregional I-O models also present a simplified version of the Canadian and United States economies. In constructing these I-O models, the specification of regional government final demand is emphasized. The fiscal response of regional governments to four federal grants is the focal point of the I-O models. The four federal grants included in these models are: unconditional grants, conditional health grants, conditional social welfare grants, and conditional education grants. Combining the fiscal response coefficients with data obtained from the AERC I-O table and the Ontario government final demand table (Kubursi, 1978, Chapter 4) the I-O models are empirically operationalized. In the next chapter these empirical I-O models are employed to determine the value of interregional income effects generated by four of the six federal grants to regional governments.

Footnotes for Chapter 6

[1]These regions represent the "Canadian" sector of the interregional I-O model which has been constructed by the Agricultural Economic Research Council (AERC) and which is employed here in analyzing the interregional income effects of federal grants.

[2]Program expenditures by Saskatchewan, Alberta, and British Columbia are not analyzed here because these provinces are not included in the interregional I-O model.

[3]An exception to this might be the cost coefficient in the equation for social welfare expenditure. A major share of social welfare expenditure is in the form of transfer payments which may be increased as the cost of living increases. Thus, social welfare expenditure may be expected to increase as prices increase. This issue is discussed in greater detail by Maley (Maley, 1972, pp. 128-129).

[4]For example, the number of automobile registrations per one thousand persons in a region is included in the transportation-communication expenditure equation. This demographic variable is not expected to affect regional government expenditure on other programs.

[5]For example, a population density variable is assumed often to reflect the effects of economies of scale. Specifically, "it is assumed that, initially, as population density increases, there are economies of scale in the provision of public goods and services but that eventually a point is reached where further crowding leads to diseconomies of scale" (Maley, 1972, p. 126). If economies of scale prevail in the provision of a program, the sign of the population density coefficient is expected to be negative. However, if diseconomies of scale are present, the expected sign of the density coefficient is positive. For a more detailed discussion of this issue, see Maley (Maley, 1972, pp. 126-127).

[6]Per capita personal income is employed because data on total regional income net of federal taxes and transfers are not available able. The personal income variable is not completely satisfactory because it is net of all business savings and indirect taxes which are an important revenue source for regional governments. However, the personal income data series is the only income data series which is available.

[7]The price of regional government programs could be derived from an industrial price index and the regional government final demand vectors.

[8]The fiscal year is the period April 1 through March 31 the following year. Data on federal grants and regional government expenditure are collected on a fiscal year basis while data on demographic characteristics, etc. are collected on a calendar year basis.

[9]This aggregation of the four Atlantic provinces to form one region is consistent with the data available in the I-O table which the Basic and Keynesian-Leontief I-O models are based on.

[10]Maley (1972, pp. 120-121) argues that "the amounts of the conditional grants can be regarded as the matching ratios weighted by the expenditures supported by the grant--since...($G_I^k = \omega_I^k E_I^k$)".

[11]For a detailed discussion of federal grants and income elasticities, see Gramlich (1969).

[12]The conclusion that the Manitoba government has a negative income elasticity for health programs is inconsistent with the income elasticities which are derived from the Linear Expenditure System. However, the functional form of the estimated expenditure equations has not been derived from a Stone Geary Utility function.

[13]As indicated in Table 2 in Chapter 2, per capita unconditional grants to Ontario are small relative to the per capita unconditional grants to other regions. Ontario did not receive equalization payments during the time period 1947-1965.

[14] Conditional health grants are excluded from this classification. In this study, conditional health grants include both conditional non-matching and conditional matching constituent grants.

[15] In addition to the implications concerning a regional government's propensity to use conditional grants as substitutes or complements to program expenditure, Gramlich (1969) also uses the response coefficients to indicate the price elasticity of programs. For example, an estimated conditional grant coefficient which is greater (less) than unity implies that the regional government's demand for the supported program is price elastic (inelastic). These implications can be drawn only for narrowly-defined, homogeneous open-ended matching grants. In the model presented here, conditional grants are broadly defined and heterogeneous. The relationship between the price elasticity for program I, ε_I, and the estimated grant coefficient, β_I,

$$\varepsilon_I = \beta_I\left(\frac{dg_I}{g_I} + \frac{d\omega_I}{\omega_I}\right),$$

does not indicate clearly whether a value of β_I which is greater (less) than unity implies that demand for the program is price elastic (inelastic). However, if the sign of the estimated coefficient for program costs and the size of the estimated grant coefficient are considered together, a statement on the elasticity of a program may be made. Cost variables are included in nine of the estimated expenditure equations. A positive (negative) cost coefficient implies that the elasticity of demand is elastic (inelastic). In seven of these equations, the elasticity which is implied from the cost variable is consistent with the elasticity which is implied by the size of the conditional grant coefficient, β_I, following Gramlich's approach. Thus, the size of the grant coefficient may provide an accurate approximation of the elasticity/inelasticity of demand for a program.

[16]The increase in education expenditure by the Quebec government in response only to unconditional grants and conditional health grants and the increase in other programs as education grants are increased appear somewhat peculiar. This peculiar response is perhaps explained by the Quebec government's traditional resistance to the perceived federal encroachment into one area of provincial jurisdiction--education. Unconditional grant revenue is used indirectly to support education programs.

[17]The most common technique employed to update I-O tables is the RAS technique. The assumption made in applying this technique is that both relative shifts in the input proportions of a certain activity and the effects of changes in productivity exert a systematic uniform influence on the rows and columns of the I-O table. (Paelinck and Nijkamp, 1975, p. 271).

[18]If the weights, γ^r, are not constant, they should at least be uncorrelated with the differences in the separate constituent coefficients, a_{ij}^{rr} (Dorfman, Samuelson and Solow, 1958, p. 242).

[19]For regional government programs which do not have a corresponding national I-O final demand vector, the weights which are used represent the other government final demand vector of the national I-O model. These programs are social welfare, and transportation and communication.

CHAPTER 7

THE REGIONAL AND INTERINDUSTRY DISTRIBUTION OF EMPLOYMENT INCOME

7.1 Introduction

In this chapter, estimates of the regional and interindustry distribution of employment income generated by increased federal grants are presented. These estimates illustrate how the methodology developed in Chapters 4 and 5 can be applied to the analysis of federal-provincial grants in Canada. Employment income effects are calculated for each region at an aggregate regional level, as the regional income distribution, and at a disaggregate industry level, as the interindustry income distribution. In addition, grant multipliers are calculated for each federal grant. In the derivation of these income effects and grant multipliers, investment, and government taxes and borrowing are assumed to be constant.[1] Thus, the calculated income effects and multipliers represent short-run or impact effects of the increased federal grants.

The general approach is to assume a ten dollar per capita increase in federal equalization payments, which are one component of federal unconditional grants, and three conditional grants; health, social welfare, and education grants to four Canadian regions.[2] The regions included in the analysis are those regions represented in the empirical I-O model: the Atlantic provinces, Quebec, Ontario, Manitoba, and the United States.

Changes in the interindustry distribution of employment income are summarized in the direct plus indirect plus induced employment income effects, DII. The study of income effects at this disaggregate level facilitates analysis of the impact of increases in individual grants on the growth of employment income in specific industries. The calculation of local and spillover DII income effects identifies the region in which additional employment income is generated. Estimates of the interindustry distribution of employment income induced by changes in the four grants are presented in Section 7.2.

Aggregating the interindustry income effects in a region, the regional income effects of changes in federal grants are derived. Thus, the induced change in the interindustry distribution of employment income is accompanied by a simultaneous change in the regional distribution of employment income. The changes in the regional distribution of employment income are summarized in three income effects:

1. the initial income effect;
2. the initial plus direct plus indirect income effect (IDI); and
3. the initial plus direct plus indirect plus induced income effect (IDII).

Each income effect represents a separate round in the simultaneous expansion of output and employment income. To highlight the <u>regional</u> income distribution, these income effects are subdivided into local and spillover income effects. Local income effects are estimates of income accruing to labour in the region receiving the grant, and spillover income effects indicate the income accruing to labour in non-recipient regions. All employment income effects are presented in per capita terms;

for example, total employment income which accrues to a region relative to the population of that region. In this representation of employment income, the local and spillover income effects of federal grants are normalized for the size of the region where the income accrues.[3]

These two levels of local and spillover income effects have significant implications for the regional allocation of federal grants. They indicate the extent that employment income induced by federal grants spills over into non-recipient regions.

7.2 The Interindustry Distribution of Employment Income

In this section, estimates of the interindustry distribution of DII employment income generated by a ten dollar per capita increase in four federal grants are analyzed. These income effects provide estimates of the extent that income generated by federal grants spills over into non-grant-recipient regions or is retained as local income in the recipient region. In addition, the income effects reported by industry indicate:

1. the extent to which employment income effects induced by a single grant differ between two industries located in the same region;
2. the extent to which employment income effects induced by a single grant differ between two similar industries located in different regions; and
3. the extent to which employment income effects induced by two different grants differ in the same industry.

The dominant pattern of these spillovers shows that non-recipient regions receive significant spillover benefits from increases in the four grants. In addition, these spillovers are not equal in all industries. The employment income accruing to an industry depends upon the type of grant and the identity of the recipient region. These interindustry employment income effects are important in that they may or may not complement the regional industrial growth strategy of the federal government.

The employment income effects of equalization payments and conditional grants are discussed in Sections 7.2.1 and 7.2.2, respectively.

7.2.1 Equalization Payments

First, consider the DII employment income effects in each industry of the five regions by a ten dollar per capita increase in equalization payments. These income effects are reported in Table 7.1. As Ontario was not a recipient of equalization payments in fiscal year 1965, a column for Ontario is not included in Table 7.1 Each cell in the table corresponds to an I-O sector (industry); the rows are industries and the columns represent grant recipient regions. There are two entries in each cell. The first entry is the per capita DII employment income generated by direct, indirect, and induced output effects in the industry. The second entry is the rankings of the additional DII per capita employment income generated in the industry. The industry is ranked first with respect to the income generated in all industries in all regions. Thus, an industry is ranked relative to the DII income effects in all eighty industries -- sixteen industries in each of five regions. The second ranking describes the industry's position in terms of the income generated in all industries in the same region. Thus, each industry in a region is ranked only in relation to the other fifteen industries in the region.

TABLE 7.1

PER CAPITA DII EMPLOYMENT INCOME EFFECTS IN I-O SECTORS INDUCED BY A TEN DOLLAR PER CAPITA INCREASE IN EQUALIZATION PAYMENTS, 1965

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) MANITOBA
ATLANTIC			
1. Agr., Forestry, Fish, Fur	0.3262 (3,3)	0.0432 (25,2)	0.0019 (41,2)
2. Metalic and Non-Metalic Minerals, Fuels, Coal	0.1885 (5,5)	0.0145 (45,5)	0.0005 (63,7)
3. Food, Tobacco	0.1896 (4,4)	0.0266 (35,3)	0.0013 (49,3)
4. Rubber, Chemicals	0.0339 (19,14)	0.0014 (79,16)	0.0004 (66,9)
5. Leather, Textiles	0.0354 (17,13)	0.0057 (64,12)	0.0005 (62,6)
6. Wood, Furniture	0.0840 (11,10)	0.0059 (61,11)	0.0003 (74,14)
7. Pulp, Paper	0.0267 (22,15)	0.0130 (49,6)	0.0005 (65,8)
8. Printing, Misc. Mfg.	0.0530 (14,12)	0.0039 (70,13)	0.0004 (67,10)
9. Primary Metals	0.0674 (13,11)	0.0096 (54,8)	0.0007 (56,5)
10. Fabricated Metal Products, Machinery	0.0933 (9,9)	0.0062 (60,10)	0.0003 (78,15)
11. Transportation Equipment	0.1228 (7,7)	0.0150 (44,4)	0.0010 (54,4)
12. Electrical Equipment	0.0233 (23,16)	0.0018 (77,15)	0.0004 (71,13)
13. Non-Metalic Mineral Products	0.1256 (6,6)	0.0019 (76,14)	0.0000 (79,16)
14. Petroleum Products	0.1123 (8,8)	0.0106 (52,7)	0.0004 (68,11)
15. Construction	0.6743 (2,2)	0.0081 (56,9)	0.0004 (69,12)
16. Tertiary	3.3570 (1,1)	0.2113 (4,1)	0.0087 (21,1)

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) MANITOBA
QUEBEC			
17. Agr., Forestry, Fish Fur	0.0141 (29,6)	0.1791 (6,5)	0.0031 (32,5)
18. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0018 (64,15)	0.0600 (19,11)	0.0003 (73,16)
19. Food, Tobacco	0.0202 (24,3)	0.1946 (5,4)	0.0049 (24,3)
20. Rubber, Chemicals	0.0072 (35,7)	0.0453 (23,13)	0.0022 (38,7)
21. Leather, Textiles	0.0310 (20,2)	0.1589 (9,6)	0.0074 (22,2)
22. Wood, Furniture	0.0062 (39,8)	0.0694 (15,10)	0.0014 (47,10)
23. Pulp, Paper	0.0030 (59,14)	0.1325 (11,7)	0.0013 (51,11)
24. Printing, Misc. Mfg.	0.0036 (52,11)	0.0506 (2,3)	0.0039 (25,4)
25. Primary Metals	0.0034 (55,12)	0.0238 (37,15)	0.0012 (52,12)
26. Fabricated Metal Products, Machinery	0.0177 (26,5)	0.0995 (12,8)	0.0026 (37,6)
27. Transportation Equipment	0.0030 (57,13)	0.0393 (28,14)	0.0019 (40,9)
28. Electrical Equipment	0.0038 (50,10)	0.0183 (39,16)	0.0021 (39,8)
29. Non-Metalic Mineral Products	0.0197 (25,4)	0.0968 (13,9)	0.0005 (64,14)
30. Petroleum Products	0.0051 (44,9)	0.0558 (20,12)	0.0008 (55,13)
31. Construction	0.0014 (66,16)	1.2751 (1,1)	0.0003 (72,15)
32. Tertiary	0.0687 (12,1)	1.1408 (2,2)	0.0157 (12,1)

TABLE 7.1 (Continued)...

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) MANITOBA
ONTARIO			
33. Agr., Forestry, Fish, Fur	0.0110 (33,7)	0.0439 (24,7)	0.0033 (29,9)
34. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0008 (74,16)	0.0136 (48,15)	0.0003 (76,16)
35. Food, Tobacco	0.0117 (31,5)	0.0418 (26,8)	0.0035 (28,8)
36. Rubber, Chemicals	0.0085 (34,8)	0.0399 (27,9)	0.0036 (27,7)
37. Leather, Textiles	0.0111 (32,6)	0.0364 (29,10)	0.0030 (35,11)
38. Wood, Furniture	0.0056 (43,11)	0.0154 (43,13)	0.0019 (43,13)
39. Pulp, Paper	0.0033 (56,14)	0.0784 (14,2)	0.0027 (36,12)
40. Printing, Misc. Mfg.	0.0049 (45,12)	0.0344 (30,11)	0.0116 (17,3)
41. Primary Metals	0.0146 (28,4)	0.0676 (16,3)	0.0067 (23,5)
42. Fabricated Metal Products, Machinery	0.0303 (21,2)	0.0658 (17,4)	0.0090 (20,4)
43. Transporation Equipment	0.0060 (40,10)	0.0459 (22,5)	0.0126 (15,2)
44. Electrical Equipment	0.0047 (46,13)	0.0154 (42,14)	0.0037 (26,6)
45. Non-Metalic Mineral Products	0.0177 (27,3)	0.0235 (38,12)	0.0013 (50,14)
46. Petroleum Products	0.0024 (61,15)	0.0050 (66,16)	0.0006 (61,15)
47. Construction	0.0068 (36,9)	0.0268 (34,15)	0.0031 (33,10)
48. Tertiary	0.0867 (10,1)	0.3409 (3,1)	0.0411 (6,1)

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) MANITOBA
MANITOBA			
49. Agr., Forestry, Fish, Fur	0.0351 (18,2)	0.1582 (10,2)	0.1090 (3,3)
50. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0121 (30,3)	0.0625 (18,3)	0.0835 (4,4)
51. Food, Tobacco	0.0056 (42,6)	0.0291 (32,5)	0.0235 (8,7)
52. Rubber, Chemicals	0.0058 (41,5)	0.0292 (31,4)	0.0158 (11,9)
53. Leather, Textiles	0.0034 (54,8)	0.0070 (58,9)	0.0031 (31,16)
54. Wood, Furniture	0.0045 (47,7)	0.0144 (47,7)	0.0193 (10,8)
55. Pulp, Paper	0.0008 (73,13)	0.0059 (62,10)	0.0093 (19,14)
56. Printing, Misc. Mfg.	0.0012 (71,11)	0.0058 (63,11)	0.0495 (5,5)
57. Primary Metals	0.0026 (60,9)	0.0128 (50,8)	0.0388 (7,6)
58. Fabricated Metal Products, Machinery	0.0020 (63,10)	0.0042 (68,12)	0.0143 (13,10)
59. Transportation Equipment	0.0003 (79,16)	0.0034 (71,14)	0.0108 (18,13)
60. Electrical Equipment	0.0005 (77,14)	0.0016 (78,16)	0.0032 (30,15)
61. Non-Metalic Mineral Products	0.0005 (78,15)	0.0020 (75,15)	0.0123 (16,12)
62. Petroleum Products	0.0010 (72,12)	0.0042 (69,13)	0.0137 (14,11)
63. Construction	0.0063 (38,4)	0.0276 (33,6)	0.4943 (2,2)
64. Tertiary	0.0411 (16,1)	0.1785 (8,1)	0.7620 (1,1)

TABLE 7.1 (Continued)...

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) MANITOBA
UNITED STATES			
65. Agr., Forestry, Fish, Fur	0.0067 (37,2)	0.0261 (36,2)	0.0030 (34,2)
66. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0037 (51,5)	0.0145 (46,5)	0.0016 (46,6)
67. Food, Tobacco	0.0043 (48,3)	0.0164 (41,4)	0.0019 (42,3)
68. Rubber, Chemicals	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)
69. Leather, Textiles	0.0043 (49,4)	0.0165 (40,3)	0.0018 (44,4)
70. Wood, Furniture	0.0008 (75,14)	0.0030 (72,13)	0.0004 (70,13)
71. Pulp, Paper	0.0014 (67,10)	0.0072 (57,9)	0.0007 (58,10)
72. Printing, Misc. Mfg.	0.0030 (58,7)	0.0120 (51,6)	0.0016 (45,5)
73. Primary Metals	0.0013 (69,12)	0.0050 (65,11)	0.0006 (60,12)
74. Fabricated Metal Products, Machinery	0.0035 (53,6)	0.0104 (53,7)	0.0014 (48,7)
75. Transportation Equipment	0.0020 (62,8)	0.0083 (55,8)	0.0012 (53,8)
76. Electrical Equipment	0.0013 (70,13)	0.0048 (67,12)	0.0006 (59,11)
77. Non-Metalic Mineral Products	0.0013 (68,11)	0.0028 (73,14)	0.0003 (77,15)
78. Petroleum Products	0.0006 (76,15)	0.0022 (74,15)	0.0003 (75,14)
79. Construction	0.0016 (65,9)	0.0069 (59,10)	0.0007 (57,9)
80. Tertiary	0.0468 (15,1)	0.1789 (7,1)	0.0212 (9,1)

These two rankings are labeled the interregional rank and the regional rank, respectively. In both cases, a low rank signifies a relatively large employment income effect.

Table 7.1 lists the per capita income generated in each industry from a ten dollar per capita increase in equalization payments in 1965. The total per capita employment income increases in all but two industries. These industries are the non-metallic mineral products industry in the Atlantic provinces, and the rubber and chemical industry in the United States. First, consider the non-metallic mineral products industry in the Atlantic provinces. This industry experiences no increase in per capita DII employment income as equalization payments to Manitoba are increased by ten dollars per capita. This zero income effect is the result of demand conditions in Manitoba. An increase in expenditure on all programs by the Manitoba government does not generate any demand for non-metallic mineral products supplied by the Atlantic provinces. Second, the employment income accruing to the rubber and chemical industry in the United States does not change as equalization payments to all regional governments are increased.[4] This zero income effect is due to the small demand for this product by regional governments and the capacity of Canadian industries to meet this demand. Very few rubber and chemical products are imported from the United States.

The largest DII employment income effect occurs in the tertiary industry. This is evident if the income effects accruing in each industry are ordered on an interregional basis. The largest DII effect, \$3.36, accrues to labour employed in the Atlantic provinces' tertiary industry. The second and third largest employment income effects, \$1.27 and \$1.03, occur in the Quebec construction and tertiary industries, respectively. Each of these industries is located in a region which receives an equalization payment. Moreover, the largest spillover income effect in each non-recipient region accrues to labour employed in the tertiary industry. These large income effects result from the large wage value-added component of the tertiary industry.

Different spillover income effects are generated in a single industry located in one region if equalization payments are allocated to different regions. For example, the spillover employment income accruing to the Quebec non-metallic mineral products industry ranges from a high of $0.02, which is induced by the grant to the Atlantic provinces, to a low of $0.0005, which is induced by the grant to Manitoba. The regional ranks of these income effects are 4 and 14, respectively, while the inter-regional ranks are 25 and 64, respectively.[5]

In addition, a single equalization payment generates different spillover income effects in the same industry located in different regions. For example, consider the spillover income generated in the printing and miscellaneous manufacturing industries by additional equalization payments to the Manitoba government. This equalization payment to Manitoba generates DII spillover income effects in the printing and miscellaneous manufacturing industry of $0.004 in the Atlantic provinces, $0.0004 in Quebec, $0.01 in Ontario, and $0.002 in the United States. The inter-regional order of these spillovers is 67, 25, 17, and 45, respectively. Differences in the industrial composition of regional government expenditure and in trade coefficients contribute to these differences in local and spillover income effects induced by equalization payments.

These local and spillover income effects indicate the extent that the federal government can alter the interindustry distribution of employment income through selective granting policies. They show that the scope for interindustry redistribution of employment income is limited. In many industries, the local income effects are one-thousand percent larger than the spillover income effects. From a redistribution point of view, a wider range of income effects would be desirable. An increased scope for altering the interindustry distribution of employment income is available in the federal conditional grants.

7.2.2 Conditional Grants

In this section, the interindustry distribution of per capita employment income effects induced by a ten dollar per capita increase in three conditional grants, health grants, social welfare grants, and education grants, is discussed. The local and spillover employment income effects induced by each of these grants to the four Canadian regions are presented in Tables 7.2, 7.3, and 7.4, respectively. For each grant, two aspects of the interindustry distribution of employment income are discussed:

1. the income effects accruing in different industries located in the same region; and
2. the income effects accruing in the same industries located in different regions.

In addition, the extent to which income effects induced in a single industry differs between grants is discussed. This latter point provides a format for comparison of the income effects induced by the three conditional grants. The interindustry distribution of employment income is discussed in terms of the magnitude, and the regional and interregional rank of income effects. These employment income effects, which are disaggregated by industry, indicate that federal grants designed to stimulate regional government expenditure on specific programs cannot be attained without altering the interindustry distribution of employment income in recipient and non-recipient regions. The variation in the magnitude and the order of these income effects illustrate the unique impact of each grant and the scope for selectively altering the interindustry distribution of employment income.

Federal conditional grants are designed to stimulate regional government expenditure on the supported programs. However, the income and substitution effects characteristic of conditional grants, may induce a regional government to reallocate non-conditional grant revenue spent on programs. These expenditure stimulation effects of conditional grants, like those of equalization payments, have a unique impact on the interindustry distribution of employment income. Thus, the regional allocation of conditional grants has important implications for:

1. the distribution of employment income between industries; and
2. federal granting policies which are designed to alter the distribution of employment income between industries.

The unique local and spillover employment income effects induced by each grant are emphasized in this discussion.

Health Grants

First, consider the local and spillover per capita employment income effects generated in each industry by a ten dollar per capita increase in conditional health grants. Estimates of these income effects are presented in Table 7.2. The largest and second-largest local income effects induced in each recipient region by the increased grant accrue in the tertiary and construction industries, respectively. For example, the largest local income effect generated by this increase in health grants, \$8.89, accrues to the tertiary industry located in the Atlantic provinces. The regional and interregional ranking, and the size of local income effects generated in the other industries varies between regions. For example, the smallest local income effect induced by a health grant, \$0.01, accrues to the leather and textile industry in Manitoba. These differences in rank and size indicate the unique regional government final demands and the regional trading patterns. In the industrial regions, Quebec and Ontario, industries with a high rank are, in general, the manufacturing or processing industries; for example, the petroleum production industry. In contrast, industries with a high rank in non-industrial regions, the Atlantic provinces and Manitoba, are the primary industries, agriculture, fishing, forestry, etc. Thus, increased health grants do not generate equal local DII income effects in all industries. Local DII employment income effects vary between industries located in the same region and between the same type of industry located in different regions.

Income effects of increased health grants are not confined to recipient regions. Employment income generated by increases in this grant spills over into industries located in other regions.

These spillover income effects are presented in Table 7.2. The DII spillovers to specific industries vary significantly in regional and interregional rank, and in size. For example, the per capita spillover income effects induced by health grants range from a high of $1.82 to a low of zero. These income effects accrue in the tertiary industry in the Atlantic provinces and the rubber and chemical industry in the United States respectively, and are generated by the health grants to Quebec and all Canadian regions, respectively.[6] Furthermore, the smallest non-zero spillover generated by increased health grants, $0.0001, occurs in the non-metallic mineral products industry of the Atlantic provinces. Manitoba is the recipient of the health grant which generates this spillover.

For most regions and industries, the spillover effects are less than the local income effects generated by health grants. Exceptions to this relative order of local and spillover income effects are the leather and textile industry in Quebec and the primary metals industry in Ontario. Increased health grants to Ontario and Manitoba generate per capita spillover effects in the Quebec leather and textile industry, $0.12 and $0.03, respectively, which are larger than the per capita local income effects, $0.07 and $0.01, respectively. Similarly, the spillover income effect generated in the Ontario primary metal industry is $0.17 per capita, while the local effect in Quebec is $0.06 per capita. Thus, the size of per capita spillover effects appears to vary between industries and regions. In addition, the estimates indicate the presence of several perverse effects. In isolated cases, per capita spillover income effects generated by increased health grants are larger than the per capita local income effect.

Although the size of local and spillover effects varies, entries in Table 7.2 indicate that the regional rank of per capita local and spillover income effects are similar for all four health grants. For example, the regional rank of local and spillover income accruing in the transportation equipment industry of the Atlantic provinces ranges from fourth to sixth for all health grants. Alternatively, these spillovers range from a high of $0.08 per capita to a low of $0.003 per capita. This large variation in size but not regional order indicates that:

1. federal health grants can be employed effectively to alter the absolute level of employment income accruing to individual industries; and
2. federal health grants will be less effective in altering the relative level of employment income accruing to select industries within a region.

This conclusion regarding the redistributive effects of health grants reflects partially the similarity in regional government health final demand vectors. Thus, health grants, used in isolation, will not tend to redistribute income between industries located in the same region.

Changing the relative level of employment income, which accrues to specific industries, can be accomplished only by altering significantly the industrial composition of regional government expenditure. This change in the industrial composition of expenditure is effected through substituting social welfare grants or education grants for health grants. The interindustry distribution of employment income generated by a ten dollar per capita increase in social welfare grants is now discussed.

TABLE 7.2

PER CAPITA DII EMPLOYMENT INCOME EFFECTS IN I-0 SECTORS INDUCED BY A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL HEALTH GRANTS, 1965

Spillover to Region 16 I-0 Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
ATLANTIC				
1. Agr., Forest, Fish, Fur	1.0957 (3,3)	0.2031 (16,2)	0.0526 (31,2)	0.0087 (39,2)
2. Metalic and Non-Metalic Minerals, Fuels, Coal	0.1872 (11,10)	0.0586 (41,6)	0.0282 (43,4)	0.0020 (67,10)
3. Food, Tobacco	0.4736 (4,4)	0.1271 (28,3)	0.0282 (42,3)	0.0057 (51,4)
4. Rubber, Chemicals	0.2394 (8,8)	0.0080 (74,15)	0.0052 (73,13)	0.0064 (47,3)
5. Leather, Textiles	0.1143 (14,12)	0.0261 (56,10)	0.0072 (69,11)	0.0022 (66,9)
6. Wood, Furniture	0.2392 (9,9)	0.0259 (57,11)	0.0076 (68,10)	0.0012 (73,14)
7. Pulp, Paper	0.0776 (21,15)	0.0366 (49,8)	0.0160 (57,7)	0.0025 (63,7)
8. Printing, Misc. Mfg.	0.2477 (7,7)	0.0237 (60,12)	0.0046 (74,14)	0.0022 (65,8)
9. Primary Metals	0.0879 (20,14)	0.0272 (55,9)	0.0108 (64,8)	0.0028 (60,6)
10. Fabricated Metal Products, Machinery	0.1377 (13,11)	0.0206 (61,13)	0.0054 (72,12)	0.0010 (78,15)
11. Transportation Equipment	0.3248 (6.6)	0.0782 (37,4)	0.0189 (53,5)	0.0029 (59,5)
12. Electrical Equipment	0.0529 (23,16)	0.0077 (75,16)	0.0032 (79,16)	0.0014 (72,13)
13. Non-Metalic Mineral Products	0.1120 (15,13)	0.0114 (70,14)	0.0041 (78,15)	0.0001 (79,16)
14. Petroleum Products	0.3397 (5,5)	0.0590 (40,5)	0.0175 (54,6)	0.0018 (68,11)
15. Construction	1.8751 (2,2)	0.0585 (43,7)	0.0097 (66,9)	0.0018 (69,12)
16. Tertiary	8.8876 (1,1)	1.8193 (3,1)	0.2367 (10,1)	0.0437 (16.1)
QUEBEC				
17. Agr., Forest, Fish, Fur	0.0365 (26,4)	0.4887 (11,6)	0.1049 (23,5)	0.0134 (29.6)
18. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0028 (68,16)	0.1593 (21,12)	0.0174 (55,15)	0.0011 (76,16)
19. Food, Tobacco	0.0497 (24,3)	0.6694 (6,4)	0.1543 (18,2)	0.0200 (25,5)
20. Rubber, Chemicals	0.0335 (28,5)	0.2093 (15,10)	0.1345 (20,3)	0.0225 (22,3)
21. Leather, Textiles	0.0931 (19,2)	0.4952 (10,5)	0.1095 (22,4)	0.0300 (21,2)
22. Wood, Furniture	0.0168 (38,8)	0.1632 (20,11)	0.0336 (38,11)	0.0061 (48,9)
23. Pulp, Paper	0.0074 (56,13)	0.2397 (13,8)	0.0543 (30,8)	0.0061 (49,10)
24. Printing, Misc. Mfg.	0.0092 (51,10)	0.1481 (24,13)	0.0501 (33,9)	0.0223 (23,4)
25. Primary Metals	0.0060 (61,14)	0.0599 (39,16)	0.0278 (44,12)	0.0041 (52,11)
26. Fabricated Metal Products, Machinery	0.0307 (29,6)	0.2112 (14,9)	0.0627 (29,7)	0.0090 (38,7)
27. Transportation Equip.	0.0074 (55,12)	0.1117 (30,14)	0.0223 (49,14)	0.0038 (55,13)
28. Electrical Equipment	0.0087 (52,11)	0.0854 (35,15)	0.0248 (46,13)	0.0083 (41,8)
29. Non-Metalic Mineral Products	0.0186 (35,7)	0.2800 (12,7)	0.0378 (37,10)	0.0026 (62,14)
30. Petroleum Products	0.0132 (44.9)	1.1724 (4,3)	0.0662 (26,6)	0.0040 (53,12)
31. Construction	0.0033 (66,15)	2.3247 (2,2)	0.0120 (62,16)	0.0015 (71,15)
32. Tertiary	0.1641 (12,1)	4.1237 (1,1)	0.9137 (4,1)	0.0722 (14,1)

TABLE 7.2 (Continued)...

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
ONTARIO				
33. Agr., Forest, Fish, Fur	0.0282 (31,6)	0.1784 (18,3)	0.1754 (14,8)	0.0130 (21,5)
34. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0016 (34,8)	0.0313 (53,15)	0.0456 (34,16)	0.0011 (77,16)
35. Food, Tobacco	0.0294 (30,5)	0.1854 (17,2)	0.1743 (16,10)	0.0135 (28,10)
36. Rubber, Chemicals	0.0389 (25,3)	0.1430 (26,7)	0.2128 (13,7)	0.0366 (19,3)
37. Leather, Textiles	0.0341 (27,4)	0.1133 (29,9)	0.0650 (28,15)	0.0120 (37,12)
38. Wood, Furniture	0.0155 (40,11)	0.0384 (48,14)	0.0793 (24,12)	0.0079 (43,13)
39. Pulp, Paper	0.0083 (53,15)	0.1470 (25,6)	0.1744 (15,9)	0.0128 (22,6)
40. Printing, Misc. Mfg.	0.0132 (45,13)	0.1016 (32,10)	0.1677 (17,11)	0.0666 (15,2)
41. Primary Metals	0.0265 (33,7)	0.1706 (19,4)	0.2468 (9,5)	0.0212 (24,7)
42. Fabricated Metal Products, Machinery	0.0536 (22,2)	0.1494 (23,5)	0.2922 (8,4)	0.0325 (20,4)
43. Transportation Equipment	0.0149 (42,12)	0.1327 (27,8)	0.0655 (27,13)	0.0164 (26,8)
44. Electrical Equipment	0.0108 (47,14)	0.0457 (46,13)	0.0691 (25,14)	0.0143 (27,9)
45. Non-Metalic Mineral Products	0.0180 (36,9)	0.0585 (42,12)	0.2284 (12,6)	0.0065 (46,14)
46. Petroleum Products	0.0068 (58,16)	0.0167 (65,16)	0.7072 (5,3)	0.0030 (57,15)
47. Construction	0.0159 (39,10)	0.0803 (36,11)	1.8409 (2,2)	0,0127 (33,11)
48. Tertiary	0.1986 (10,1)	1.0141 (5,1)	3.4903 (1,1)	0.1700 (7,1)

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
MANITOBA				
49. Agr., Forest, Fish, Fur	0.1043 (17,2)	0.5228 (8,2)	0.2329 (11,3)	0.5589 (3,3)
50. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0281 (32,3)	0.1523 (22,3)	1.0501 (3,1)	0.4256 (4,4)
51. Food, Tobacco	0.0143 (43,6)	0.0947 (33,5)	0.0401 (36,7)	0.0825 (10,8)
52. Rubber, Chemicals	0.0216 (34,4)	0.1040 (31,4)	0.1489 (19,4)	0.2706 (6,6)
53. Leather, Textiles	0.0108 (48,8)	0.0237 (59,9)	0.0168 (56,12)	0.0120 (36,16)
54. Wood, Furniture	0.0126 (46,7)	0.0351 (50,7)	0.0297 (41,8)	0.0778 (12,10)
55. Pulp, Paper	0.0022 (72,13)	0.0162 (66,11)	0.0134 (60,14)	0.0406 (18,13)
56. Printing, Misc. Mfg.	0.0033 (65,11)	0.0186 (63,10)	0.0228 (48,9)	0.2953 (5,5)
57. Primary Metals	0.0055 (61,9)	0.0341 (52,8)	0.0408 (35,6)	0.1257 (8,7)
58. Fabricated Metal Products, Machinery	0.0039 (63,10)	0.0112 (71,13)	0.0154 (58,13)	0.0427 (17,12)
59. Transportation Equipment	0.0007 (79,16)	0.0099 (72,14)	0.0042 (77,16)	0.0122 (35,15)
60. Electrical Equipment	0.0012 (77,14)	0.0045 (79,16)	0.0044 (76,15)	0.0124 (34,14)
61. Non-Metalic Mineral Products	0.0011 (78,15)	0.0055 (78,15)	0.0207 (51,11)	0.0779 (11,9)
62. Petroleum Products	0.0027 (70,12)	0.0137 (69,12)	0.0213 (50,10)	0.0748 (13,11)
63. Construction	0.0173 (37,5)	0.0882 (34,6)	0.1149 (21,5)	2.0164 (2,2)
64. Tertiary	0.1116 (16,1)	0.5924 (7,1)	0.6855 (6,2)	3.8226 (1,1)

TABLE 7.2 (Continued)...

Spillover to Region 16 I-O Sectors:	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
UNITED STATES				
65. Agr., Forest, Fish Fur	0.0150 (41,2)	0.0763 (38,2)	0.0504 (32,2)	0.0132 (30,2)
66. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0079 (54,5)	0.0432 (47,6)	0.0275 (45,5)	0.0070 (45,6)
67. Food, Tobacco	0.0093 (50,4)	0.0487 (44,4)	0.0326 (39,3)	0.0084 (40,3)
68. Rubber, Chemicals	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)
69. Leather, Textiles	0.0097 (49,3)	0.0481 (45,5)	0.0298 (40,4)	0.0080 (42,4)
70. Wood, Furniture	0.0017 (74,14)	0.0085 (73,13)	0.0056 (70,13)	0.0016 (70,13)
71. Pulp, Paper	0.0030 (67,10)	0.0194 (41,3)	0.0118 (63,10)	0.0029 (58,10)
72. Printing, Misc. Mfg.	0.0066 (59,7)	0.0348 (51,7)	0.0240 (47,6)	0.0076 (44,5)
73. Primary Metals	0.0026 (71,12)	0.0139 (68,12)	0.0101 (65,12)	0.0024 (64,12)
74. Fabricated Metal Products, Machinery	0.0070 (57,6)	0.0287 (54,8)	0.0203 (52,7)	0.0059 (50,7)
75. Transportation Equipment	0.0043 (62,8)	0.0240 (58,9)	0.0148 (59,8)	0.0040 (54,8)
76. Electrical Equipment	0.0028 (69,11)	0.0140 (67,11)	0.0097 (67,11)	0.0027 (61,11)
77. Non-Metalic Mineral Products	0.0018 (73,13)	0.0076 (76,14)	0.0054 (71,14)	0.0012 (74,14)
78. Petroleum Products	0.0014 (76,15)	0.0065 (77,15)	0.0046 (75,15)	0.0012 (75,15)
79. Construction	0.0035 (64,9)	0.0190 (62,10)	0.0126 (61,9)	0.0032 (56,9)
80. Tertiary	0.1012 (18,1)	0.5179 (9,1)	0.3481 (7,1)	0.0929 (9,1)

Social Welfare Grants

The per capita local and spillover DII employment income effects generated in each industry by a ten dollar per capita increase in social welfare grants are presented in Table 7.3. These income effects which accrue in each industry are varied. This variation in local and spillover income effects indicates that the regional allocation of federal social welfare grants will alter the distribution of income between industries and regions. Furthermore, this interindustry distribution of employment income is unique. The size and rank of income effects in individual industries generated by social welfare grants differ between grant recipients and between other types of grants; for example, health grants. In this section, the per capita local and spillover income effects of increased social welfare grants are discussed. These income effects are compared with those generated by health grants. This comparison illustrates that social welfare grants generate unique local and spillover income effects.

First, consider the local income effects induced by increased social welfare grants. The size and rank of these local income effects are varied. They range from a high of $11.29 per capita in the tertiary industry of the Atlantic provinces to a low of $0.01 per capita in the Manitoba electrical equipment industry. Furthermore, the magnitude of these local income effects differs significantly from those induced by other conditional grants. This difference emphasizes the uniqueness of local income effects induced by social welfare grants.

Compare the per capita local income effects generated by social welfare grants and health grants on an industry-by-industry basis.

TABLE 7.3

PER CAPITA DII EMPLOYMENT INCOME EFFECTS IN I-0 SECTORS INDUCED BY
A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL SOCIAL WELFARE GRANTS, 1965

Spillover to Regions 16 I-0 Sectors: ATLANTIC	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
1. Agr., Forest, Fish, Fur	1.2304 (2,2)	0.0693 (15,2)	0.0300 (31,3)	0.0088 (39,2)
2. Metalic and Non-Metalic Minerals, Fuels, Coal	0.1509 (10,8)	0.0294 (33,4)	0.0334 (28,2)	0.0021 (66,9)
3. Food, Tobacco	0.7577 (3,3)	0.0430 (24,3)	0.0163 (43,4)	0.0060 (47,3)
4. Rubber, Chemicals	0.0630 (20,14)	0.0036 (72,15)	0.0059 (67,11)	0.0030 (58,6)
5. Leather, Textiles	0.1373 (12,10)	0.0087 (56,11)	0.0042 (70,12)	0.0026 (61,7)
6. Wood, Furniture	0,1458 (11,9)	0.0115 (51,9)	0.0071 (60,8)	0.0012 (73,14)
7. Pulp, Paper	0.0951 (16,11)	0.0100 (54,10)	0.0089 (54,6)	0.0022 (64,8)
8. Printing	0.5066 (4,4)	0.0121 (48,8)	0.0035 (73,15)	0.0017 (69,12)
9. Primary Metals	0.0816 (19,13)	0.0087 (57,12)	0.0060 (66,10)	0.0032 (56,5)
10. Fabricated Metal Products, Machinery	0.0929 (17,12)	0.0071 (60,13)	0.0039 (71,13)	0.0011 (78,15)
11. Transportation Equipment	0.4100 (5,5)	0.0278 (37,5)	0.0097 (53,5)	0.0040 (54,4)
12. Electrical Equipment	0.0444 (22,15)	0.0027 (73,16)	0.0019 (79,16)	0.0015 (72,13)
13. Non-Metalic Mineral Products	0.0220 (31,16)	0.0061 (63,14)	0.0038 (72,14)	0.0001 (79,16)
14. Petroleum Products	0.3760 (6,6)	0.0205 (40,7)	0.0078 (56,7)	0.0017 (67,10)
15. Construction	0.3728 (7,7)	0.0228 (39,6)	0.0064 (64,9)	0.0017 (68,11)
16. Tertiary	11.2927 (1,1)	0.7218 (2,1)	0.1564 (0,1)	0.0402 (19,1)

Spillover to Regions 16 I-0 Sectors: QUEBEC	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
17. Agr., Forest, Fish, Fur	0.0396 (25,4)	0.1169 (13,7)	0.0563 (22,5)	0.0139 (32,5)
18. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0019 (72,16)	0.1972 (6,3)	0.0550 (23,6)	0.0012 (74,16)
19. Food, Tobacco	0.0621 (21,3)	0.1556 (7,4)	0.0707 (18,3)	0.0223 (24,3)
20. Rubber, Chemicals	0.0154 (36,6)	0.1073 (14,8)	0.1064 (14,2)	0.0132 (33,6)
21. Leather, Textiles	0.1057 (15,2)	0.1284 (11,5)	0.0639 (20,4)	0.0366 (20,2)
22. Wood, Furniture	0.0117 (43,8)	0.0596 (18,11)	0.0283 (33,11)	0.0059 (48,10)
23. Pulp, Paper	0.0072 (53,12)	0.0428 (25,13)	0.0294 (20,10)	0.0057 (51,11)
24. Printing, Misc. Mfg.	0.0094 (45,9)	0.0610 (17,10)	0.0336 (27,8)	0.0162 (26,4)
25. Primary Metals	0.0050 (59,13)	0.0187 (43,15)	0.0145 (47,13)	0.0049 (52,12)
26. Fabricated Metal Products, Machinery	0.0241 (29,5)	0.0641 (16,9)	0.0348 (26,7)	0.0106 (38,7)
27. Transportation Equipment	0.0079 (51,10)	0.0289 (34,14)	0.0135 (48,14)	0.0071 (44,9)
28. Electrical Equipment	0.0075 (52,11)	0.0157 (44,16)	0.0119 (50,15)	0.0086 (40,8)
29. Non-Metalic Mineral Products	0.0048 (61,14)	0.1228 (12,6)	0.0311 (30,9)	0.0022 (65,14)
30. Petroleum Products	0.0130 (41,7)	0.0517 (19,12)	0.0227 (37,12)	0.0038 (55,13)
31. Construction	0.0031 (65,15)	0.6831 (3,2)	0.0073 (58,16)	0.0015 (71,15)
32. Tertiary	0.1569 (9,1)	0.8973 (1,1)	0.5355 (3,1)	0.0717 (12,1)

TABLE 7.3 (Continued)...

Spillover to Regions 16 I-O Sectors ONTARIO	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
33. Agr., Forest, Fish, Fur	0.0370 (27,5)	0.0403 (27,7)	0.0571 (21,11)	0.0148 (31,10)
34. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0012 (75,16)	0.0435 (23,5)	0.3171 (6,3)	0.0011 (77,16)
35. Food, Tobacco	0.0414 (24,3)	0.0397 (28,8)	0.0473 (25,12)	0.0159 (28,7)
36. Rubber, Chemicals	0.0187 (44,7)	0.0478 (20,2)	0.1100 (13,8)	0.0212 (25,6)
37. Leather, Textiles	0.0391 (26,4)	0.0300 (32,10)	0.0330 (29,13)	0.0150 (29,8)
38. Wood, Furniture	0.0102 (44,11)	0.0149 (45,14)	0.0681 (19,10)	0.0079 (42,13)
39. Pulp, Paper	0.0080 (50,13)	0.0279 (36,12)	0.0928 (16,9)	0.0117 (37,12)
40. Printing, Misc. Mfg.	0.0139 (39,10)	0.0418 (26,6)	0.1179 (12,7)	0.0469 (16,2)
41. Primary Metals	0.0225 (30,6)	0.0472 (21,3)	0.1217 (11,6)	0.0267 (23,5)
42. Fabricated Metal Products, Machinery	0.0427 (23,2)	0.0468 (22,4)	0.1531 (10,5)	0.0361 (22,4)
43. Transportation Equipment	0.0167 (35,8)	0.0346 (30,9)	0.0254 (34,14)	0.0431 (17,3)
44. Electrical Equipment	0.0092 (46,12)	0.0117 (50,15)	0.0250 (36,15)	0.0149 (30,9)
45. Non-Metalic Mineral Products	0.0060 (57,15)	0.0204 (41,13)	0.1882 (7,4)	0.0057 (50,14)
46. Petroleum Products	0.0069 (54,14)	0.0048 (65,16)	0.0225 (38,16)	0.0026 (62,15)
47. Construction	0.0145 (38,9)	0.0279 (35,11)	1.2893 (2,2)	0.0129 (34,11)
48. Tertiary	0.1772 (8,1)	0.3548 (4,1)	1.5853 (1,1)	0.1718 (6,1)

Spillover to Regions 16 I-O Sectors MANITOBA	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
49. Agr., Forest, Fish, Fur	0.1164 (13,1)	0.1309 (4,1)	0.0966 (15,3)	0.5616 (3,3)
50. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0266 (28,3)	0.1526 (10,3)	0.3790 (4,1)	0.3845 (4,4)
51. Food, Tobacco	0.0190 (32,4)	0.0242 (8,2)	0.0175 (41,8)	0.1077 (9,8)
52. Rubber, Chemicals	0.0145 (37,6)	0.0391 (38,6)	0.0862 (17,4)	0.1243 (8,7)
53. Leather, Textiles	0.0126 (42,7)	0.0062 (62,10)	0.0080 (55,11)	0.0162 (27,15)
54. Wood, Furniture	0.0085 (48,8)	0.0112 (52,7)	0.0183 (39,6)	0.0797 (11,9)
55. Pulp, Paper	0.0024 (69,13)	0.0043 (68,12)	0.0071 (61,13)	0.0408 (18,14)
56. Printing, Misc. Mfg.	0.0034 (64,11)	0.0075 (59,9)	0.0114 (51,10)	0.1975 (5,5)
57. Primary Metals	0.0049 (60,9)	0.0109 (53,8)	0.0179 (40,7)	0.1649 (7,6)
58. Fabricated Metal Products, Machinery	0.0035 (63,10	0.0040 (69,13)	0.0070 (62,4)	0.0559 (15,12)
59. Transportation Equipment	0.0007 (79,16)	0.0027 (74,14)	0.0019 (77,15)	0.0364 (21,13)
60. Electrical Equipment	0.0010 (77,14)	0.0014 (79,16)	0.0019 (78,16)	0.0127 (36,16)
61. Non-Metalic Mineral Products	0.0010 (78,15)	0.0019 (77,15)	0.0167 (42,9)	0.0589 (14,11)
62. Petroleum Products	0.0028 (67,12)	0.0046 (66,11)	0.0072 (59,12)	0.0647 (13,10)
63. Construction	0.0179 (34,5)	0.0320 (31,5)	0.0503 (24,5)	2.0549 (2,2)
64. Tertiary	0.1150 (14,2)	0.2096 (5,1)	0.3213 (5,2)	3.2423 (1,1)

TABLE 7.3 (Continued)...

Spillover to Regions 16 I-O Sectors U.S.A.	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
65. Agr., Forest, Fish, Fur	0.0134 (40,2)	0.0203 (42,2)	0.0253 (35,2)	0.0129 (35,2)
66. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0068 (55,5)	0.0118 (49,5)	0.0150 (46,5)	0.0068 (46,6)
67. Food, Tobacco	0.0083 (49,4)	0.0129 (47,4)	0.0162 (44,3)	0.0082 (41,3)
68. Rubber, Chemicals	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)
69. Leather, Textiles	0.0088 (47,3)	0.0130 (46,3)	0.0154 (45,4)	0.0079 (43,4)
70. Wood, Furniture	0.0015 (73,13)	0.0023 (75,13)	0.0030 (75,14)	0.0015 (70,12)
71. Pulp, Paper	0.0026 (68,10)	0.0046 (67,10)	0.0061 (65,10)	0.0028 (59,11)
72. Printing, Misc. Mfg.	0.0058 (58,7)	0.0096 (55,6)	0.0125 (49,6)	0.0068 (45,5)
73. Primary Metals	0.0023 (71,12)	0.0036 (71,12)	0.0049 (68,11)	0.0024 (73,13)
74. Fabricated Metal Products, Machinery	0.0060 (56,6)	0.0080 (78,7)	0.0104 (52,7)	0.0058 (49,7)
75. Transportation Equipment	0.0039 (62,8)	0.0064 (61,8)	0.0074 (57,8)	0.0046 (53,8)
76. Electrical Equipment	0.0024 (70,11)	0.0037 (70,11)	0.0048 (69,12)	0.0026 (60,12)
77. Non-Metalic Mineral Products	0.0011 (76,15)	0.0023 (76,14)	0.0033 (74,13)	0.0012 (76,15)
78. Petroleum Products	0.0012 (74,14)	0.0017 (78,15)	0.0022 (76,15)	0.0012 (75,14)
79. Construction	0.0031 (66,9)	0.0051 (64,9)	0.0066 (63,9)	0.0031 (57,9)
80. Tertiary	0.0881 (18,1)	0.1400 (9,1)	0.1785 (8,1)	0.0897 (10,1)

In general, increases in social welfare grants induce local income effects which are less than those induced by increased health grants. Furthermore, the regional order of approximately 20 percent of the local income effects generated by social welfare grants differ significantly from the regional order of the local effects induced by health grants. For example, the construction industry in the Atlantic provinces receives the seventh largest increase in local employment income, $0.37 per capita, as social welfare grants are increased by ten dollars per capita. An equal increase in health grants to the Atlantic provinces generates additional local employment income of $1.88 per capita in this industry. This latter income effect is the second-largest local income effect induced by this health grant. These local income effects indicate the unique magnitude and regional rank of DII employment income induced by increased social welfare grants. The level of regional income and the interindustry distribution of additional employment income is altered by substituting social welfare grants for health grants.

Second, consider the per capita spillover income effects induced by increased social welfare grants. These spillovers, like the local income effects vary significantly between industries. In addition, the spillover effects induced by social welfare grants are unique. These spillover effects range from a high of $0.72 per capita, which is generated in the Atlantic provinces' tertiary industry by the grant to Quebec, to a low of zero in the rubber and chemical industry of the United States. As in the case of local income effects, spillover employment income effects from social welfare grants are smaller, in general, than spillovers generated by health grants. However, the regional order of these spillover effects is not altered significantly from spillovers induced by health grants. The changes in the regional order and magnitude of spillover effects which do occur are specific to a particular industry and grant. For example, consider the spillovers generated in the Ontario metallic and non-metallic minerals, fuels, and coal industry. Both health and social welfare grants to Manitoba induce a per capita spillover which is ranked 77th interregionally and 16th regionally. The value of these spillovers induced by both health and social welfare grants is $0.0011. Alternatively, spillovers in this industry generated by health and social welfare grants to Quebec induce spillovers which are interregionally ranked 53rd and 23rd, respectively, and regionally ranked 15th and 5th, respectively. The values of these health and social welfare induced spillovers are $0.031 and $0.044, respectively. In general, the spillover employment income effects which are generated by social welfare grants are unique.

The estimated per capita local and spillover employment income effects of social welfare grants are varied. Thus, the regional allocation of federal social welfare grants will alter the regional distribution of employment income directly through the local income effects and indirectly through the spillover income effects. Furthermore, the industrial distribution of employment income which results from this allocation of social welfare grants is unique. This uniqueness is a result of the differential fiscal response of regional governments to increased conditional grants and the industrial composition of this increased regional government program expenditure. These differences are highlighted in a comparison of the income effects which are generated by increased social welfare grants and health grants.

Education Grants

In this section the per capita local and spillover employment income effects induced by a ten dollar per capita increase in education grants are discussed. These income effects are presented in Table 7.4. Both local and spillover income effects exhibit variation between industries. As in the case of other grants, this variation exists between different industries located in the same region and the same industries located in different regions. In addition, these income effects are uniquely determined by the ten dollar per capita increase in education grants.

First, consider the local employment income effects which are induced by increased education grants. As in the case of other conditional grants, the largest per capita local income effects occur, in general, in the tertiary industries. This large income effect in the tertiary industry represents the large wage value-added component in this industry. For example, the largest of these income effects is $12.36, which occurs in the tertiary industry of the Atlantic provinces. This income effect is in contrast to the per capita local effect which occurs in the non-metallic mineral products industry, $0.019, and which is the smallest local effect in the Atlantic provinces induced by the increased education grant. Similarly, the other three regions experience a large variation in local employment income accruing to individual industries. The variation in local income effects generated in different industries located in the same region is significant.

Second, consider the per capita spillover income effects of increased education grants. As in the case of local income effects

TABLE 7.4

PER CAPITA DII EMPLOYMENT INCOME EFFECTS IN I-O SECTORS INDUCED BY A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL EDUCATION GRANTS, 1965

Spillover to Regions 16 I-O Sectors ATLANTIC	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
1. Agr., Forest, Fish, Fur	0,9483 (2,2)	0.1047 (27,2)	0,0230 (31,2)	0.0104 (39,2)
2. Metalic and Non-Metalic Minerals, Fuels, Coal	0,1439 (10,9)	0.0239 (52,6)	0,0115 (48,4)	0.0021 (65,9)
3. Food, Tobacco	0,5984 (4,4)	0.0687 (33,3)	0,0107 (50,5)	0.0070 (47,3)
4. Rubber, Chemicals	0,0367 (23,15)	0.0035 (78,15)	0,0007 (79,16)	0.0035 (60,6)
5. Leather, Textiles	0,0973 (12,10)	0.0140 (62,11)	0,0032 (72,12)	0.0015 (73,13)
6. Wood, Furniture	0,1547 (8,8)	0.0159 (60,10)	0,0041 (68,11)	0.0014 (74,14)
7. Pulp, Paper	0,0648 (18,12)	0.0221 (53,7)	0,0140 (45,3)	0.0030 (63,7)
8. Printing, Misc. Mfg.	0,7241 (3,3)	0.0103 (71,13)	0,0019 (75,14)	0.0039 (57,4)
9. Primary Metals	0,0449 (21,14)	0.0220 (54,8)	0,0066 (61,7)	0.0028 (64,8)
10. Fabricated Metal Products, Machinery	0,0843 (15,11)	0.0129 (64,12)	0,0058 (64,8)	0.0010 (78,15)
11. Transportation Equipment	0,4558 (5,5)	0.0577 (36,4)	0,0071 (58,6)	0.0035 (58,5)
12. Electrical Equipment	0,0476 (20,13)	0.0050 (75,14)	0,0021 (74,13)	0.0018 (69,12)
13. Non-Metalic Mineral Products	0,0186 (31,16)	0.0011 (79,16)	0,0011 (78,15)	0.0001 (79,16)
14. Petroleum Products	0,3158 (7,7)	0.0261 (51,5)	0,0053 (65,9)	0.0020 (66,10)
15. Construction	0,3801 (6,6)	0.0163 (57,9)	0,0041 (67,10)	0.0019 (68,11)
16. Tertiary	12,3613 (1,1)	0.3924 (10,1)	0,0993 (11,1)	0.0470 (16,1)

Spillover to Regions 16 I-O Sectors QUEBEC	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
17. Agr., Forest, Fish, Fur	0,0314 (25,4)	0.4112 (9,6)	0,0513 (17,3)	0.0165 (32,5)
18. Metalic and Non-Metalic Minerals, Fuels, Coal	0,0016 (72,16)	0.0465 (40,16)	0,0136 (46,14)	0.0012 (76,16)
19. Food, Tobacco	0,0494 (19,3)	0.5814 (4,3)	0,0369 (22,6)	0.0260 (22,3)
20. Rubber, Chemicals	0,0111 (41,7)	0.1244 (22,12)	0,0237 (29,7)	0.0159 (33,6)
21. Leather, Textiles	0,0770 (17,2)	0.4479 (8,4)	0,0437 (19,4)	0.0217 (25,4)
22. Wood, Furniture	0,0115 (39,6)	0.2183 (14,9)	0,0206 (33,8)	0.0067 (48,10)
23. Pulp, Paper	0,0057 (56,12)	0.0799 (30,13)	0,0646 (14,2)	0.0080 (44,9)
24. Printing, Misc. Mfg.	0,0086 (46,9)	0.3317 (12,7)	0,0194 (34,9)	0.0413 (18,2)
25. Primary Metals	0,0043 (60,13)	0.0477 (39,15)	0,0179 (37,11)	0.0047 (53,12)
26. Fabricated Metal Products, Machinery	0,0239 (28,5)	0.2566 (13,8)	0,0412 (21,5)	0.0103 (40,8)
27. Transportation Equipment	0,0074 (50,11)	0.2171 (15,9)	0,0109 (49,15)	0.0052 (51,11)
28. Electrical Equipment	0,0076 (49,10)	0.0607 (35,14)	0,0145 (42,12)	0.0106 (38,7)
29. Non-Metalic Mineral Products	0,0041 (61,14)	0.1273 (21,11)	0,0192 (35,10)	0.0017 (70,14)
30. Petroleum Products	0,0107 (42,8)	0.1796 (16,10)	0,0143 (43,13)	0.0044 (54,13)
31. Construction	0,0025 (66,15)	1.7802 (2,2)	0,0040 (69,16)	0.0017 (71,15)
32. Tertiary	0,1259 (11,1)	5.9830 (1,1)	0,2109 (5,1)	0.0799 (13,1)

TABLE 7.4 (Continued)...

Spillover to Regions 16 I-O Sectors	RECIPIENT REGIONS:			
ONTARIO	(1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
33. Agr., Forest, Fish, Fur	0.0296 (26,4)	0.1274 (20,6)	0.0420 (20,11)	0.0177 (30,10)
34. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0010 (76,16)	0.0117 (69,16)	0.0540 (16,9)	0.0012 (77,16)
35. Food, Tobacco	0.0329 (24,3)	0.1227 (23,7)	0.0235 (30,15)	0.0189 (27,7)
36. Rubber, Chemicals	0.0137 (36,9)	0.1100 (24,8)	0.0486 (18,10)	0.0260 (21,4)
37. Leather, Textiles	0.0284 (27,5)	0.1054 (25,9)	0.0292 (26,13)	0.0081 (43,12)
38. Wood, Furniture	0.0104 (43,11)	0.0457 (41,13)	0.0683 (13,8)	0.0074 (46,13)
39. Pulp, Paper	0.0064 (52,13)	0.0538 (37,11)	0.3344 (3,3)	0.0180 (29,9)
40. Printing, Misc. Mfg.	0.0138 (35,8)	0.1709 (18,4)	0.0744 (12,7)	0.1280 (9,2)
41. Primary Metals	0.0203 (30,6)	0.1498 (19,5)	0.1713 (9,5)	0.0252 (24,6)
42. Fabricated Metal Products, Machinery	0.0422 (22,2)	0.1736 (17,3)	0.2337 (4,4)	0.0382 (19,3)
43. Transportation Equipment	0.0168 (32,7)	0.2587 (12,2)	0.0262 (28,14)	0.0258 (23,5)
44. Electrical Equipment	0.0094 (44,12)	0.0513 (38,12)	0.0309 (23,12)	0.0184 (28,8)
45. Non-Metalic Mineral Products	0.0051 (58,15)	0.0432 (44,14)	0.1380 (10,6)	0.0048 (52,14)
46. Petroleum Products	0.0057 (55,14)	0.0137 (63,15)	0.0162 (41,16)	0.0033 (61,15)
47. Construction	0.0124 (37,10)	0.0711 (32,10)	2.2919 (1,1)	0.0159 (34,11)
48. Tertiary	0.1531 (9,1)	0.9128 (3,1)	1.7523 (2,2)	0.2166 (6,1)

Spillover to Regions 16 I-O Sectors	RECIPIENT REGIONS:			
MANITOBA	(1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
49. Agr., Forest, Fish, Fur	0.0951 (14,2)	0.4657 (6,2)	0.0615 (15,3)	0.4961 (5.5)
50. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0223 (29,3)	0.1053 (26,3)	0.1771 (8,2)	0.5097 (4,4)
51. Food, Tobacco	0.0152 (33,4)	0.0859 (28,4)	0.0101 (51,8)	0.1291 (8,7)
52. Rubber, Chemicals	0.0114 (40,6)	0.0801 (29,5)	0.0307 (24,4)	0.1439 (7,6)
53. Leather, Textiles	0.0091 (45,7)	0.0161 (59,11)	0.0074 (57,11)	0.0060 (49,16)
54. Wood, Furniture	0.0085 (47,8)	0.0438 (42,7)	0.0228 (32,6)	0.0615 (14,10)
55. Pulp, Paper	0.0020 (71,13)	0.0126 (66,12)	0.0100 (52,9)	0.0574 (15,11)
56. Printing, Misc. Mfg.	0.0029 (64,11)	0.0177 (55,9)	0.0069 (59,12)	0.5978 (3,3)
57. Primary Metals	0.0045 (59,9)	0.0264 (50,8)	0.0171 (39,7)	0.1091 (11,8)
58. Fabricated Metal Products Machinery	0.0034 (63,10)	0.0121 (67,13)	0.0065 (62,13)	0.0465 (17,12)
59. Transportation Equipment	0.0006 (79,16)	0.0176 (56,10)	0.0016 (77,16)	0.0204 (26,14)
60. Electrical Equipment	0.0010 (75,14)	0.0049 (77,16)	0.0018 (76,15)	0.0159 (35,15)
61. Non-Metalic Mineral Products	0.0008 (78,15)	0.0050 (76,15)	0.0074 (56,10)	0.0273 (20,13)
62. Petroleum Products	0.0023 (67,12)	0.0115 (70,14)	0.0044 (66,14)	0.0918 (12,9)
63. Construction	0.0149 (34,5)	0.0743 (31,6)	0.0286 (27,5)	0.6345 (2,2)
64. Tertiary	0.0963 (13,1)	0.4834 (5,1)	0.1794 (7,1)	5.9883 (1,1)

TABLE 7.4 (Continued)...

Spillover to Regions 16 I-O Sectors U.S.A.	RECIPIENT REGIONS: (1) ATLANTIC	(2) QUEBEC	(3) ONTARIO	(4) MANITOBA
65. Agr., Forest, Fish, Fur	0.0118 (38,2)	0.0668 (34,2)	0.0299 (25,2)	0.0170 (31,2)
66. Metalic and Non-Metalic Minerals, Fuels, Coal	0.0061 (53,5)	0.0352 (46,5)	0.0165 (40,5)	0.0089 (42,6)
67. Food, Tobacco	0.0074 (51,4)	0.0427 (45,4)	0.0186 (36,3)	0.0109 (37,4)
68. Rubber, Chemicals	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)	0.0000 (80,16)
69. Leather, Textiles	0.0076 (48,3)	0.0435 (43,3)	0.0176 (38,4)	0.0101 (41,5)
70. Wood, Furniture	0.0013 (73,13)	0.0078 (72,13)	0.0036 (70,13)	0.0020 (67,13)
71. Pulp, Paper	0.0023 (68,10)	0.0142 (61,10)	0.0098 (53,8)	0.0039 (56,10)
72. Printing, Misc. Mfg.	0.0052 (57,7)	0.0344 (47,6)	0.0140 (44,6)	0.0110 (36,3)
73. Primary Metals	0.0021 (70,12)	0.0120 (68,12)	0.0067 (60,11)	0.0030 (62,12)
74. Fabricated Metal Products, Machinery	0.0057 (54,6)	0.0281 (48,7)	0.0129 (47,7)	0.0075 (45,7)
75. Transportation Equipment	0.0036 (62,8)	0.0264 (49,8)	0.0085 (54,9)	0.0053 (50,8)
76. Electrical Equipment	0.0022 (69,11)	0.0129 (65,11)	0.0058 (63,12)	0.0035 (59,11)
77. Non-Metalic Mineral Products	0.0010 (77,15)	0.0062 (73,14)	0.0035 (71,14)	0.0014 (75,15)
78. Petroleum Products	0.0011 (74,14)	0.0058 (74,15)	0.0026 (73,15)	0.0016 (72,14)
79. Construction	0.0027 (65,9)	0.0161 (58,9)	0.0085 (55,10)	0.0042 (55,9)
80. Tertiary	0.0786 (16,1)	0.4648 (7,1)	0.2101 (6,1)	0.1207 (10,1)

induced by increased education grants, these spillovers vary dramatically between industries and regions. This variation in spillovers indicates that the regional allocation of education grants has an important impact on the industrial distribution of employment income. Furthermore, the industrial distribution of employment income is altered as education grants are substituted for other conditional grants. This situation arises because education grants induce DII employment income effects of unique rank and size. The largest of these spillover income effects of education grants, $0.91, is generated in the Ontario tertiary industry by the grant to Quebec. In contrast, the smallest, non-zero spillover which is generated by education grants, $0.0001, is induced in the Manitoba non-metalic mineral products industry by the education grant to the Atlantic provinces.[7]

The uniqueness of spillover income effects generated by education grants is illustrated in the comparison of these income effects with those generated by the other two conditional grants. In general, a ten dollar per capita increase in the health grants to the Atlantic provinces, Quebec, and Ontario generates larger per capita spillover income effects than does an equivalent increase in the other conditional grants. In contrast, the largest spillovers from Manitoba to the other regions tend to be generated by the education grant to Manitoba. Greater diversity is apparent in the ranking of the second and third largest spillovers generated by conditional grants. In the Atlantic provinces and Ontario, social welfare grants induce greater spillovers than do equivalent education grants. This general pattern is reversed for Quebec. Education grants to Quebec induce greater spillovers than do social welfare grants to this region. Alternatively, no general pattern of spillovers is dominant for equivalent health and social welfare grants to Manitoba.

The regional rank of the spillover income effects induced by increased education grants differs only slightly from the ranking of spillovers induced by the other conditional grants. These differences in the order and the magnitude of local and spillover income effects indicate the extent to which employment income can be redistributed between industries. This redistribution is accomplished through substituting education grants for health or social welfare grants. These variations in the interindustry local and spillover income effects of federal conditional grants to different regional governments may be attributed to three factors:

1. each regional government exhibits a different fiscal response to each conditional grant;
2. the industrial composition of each regional government's final demand expenditure is different; and
3. the wage value-added differs between industries in the same region and between the same industries in different regions.

7.2.3. Conclusion

The interindustry variation in the DII employment income effects illustrates the diverse impact of federal equalization payments and conditional grants. This diverse impact indicates the extent to which the federal government can pursue a select granting policy designed to attain a specific interindustry distribution of employment income. The income effects of federal grants can be directed toward altering:

1. the per capita employment income accruing to a specific industry in all regions;
2. the per capita employment income accruing to all industries located in a specific region; or
3. the per capita employment income accruing to a specific industry in one region.

For example, a ten dollar per capita increase in the equalization payment to Quebec generates a larger aggregate employment income effect in the construction industries than equivalent per capita increases in equalization payments to other regions. This grant, however, maximizes the spillover to the United States. Alternatively, if the federal government wishes to maximize the per capita employment income accruing to the tertiary industry in the Atlantic provinces <u>and</u> the non-metallic mineral products industry in Ontario for a given per capita increase in equalization payments, the appropriate policy is to allocate this increase in equalization payments to the Atlantic provinces.

In general, the scope for specific employment income distribution policies employing equalization payments and conditional grants is broad. This scope for various employment income distribution policies reflects the large variation in local and spillover employment income effects generated by equalization payments.

The estimates of employment income effects presented in this section indicate that local and spillover income effects generated by equalization payments and conditional grants are not equal in all industries or regions. In addition, these income effects may vary in accordance with the region receiving the grant. In the next section, estimates of the employment income effects of equalization payments and conditional grants are presented at a more aggregate level. Local and spillover income effects are discussed on a regional basis rather than the industry level presented in this section.

7.3 The Regional Distribution of Employment Income

The interindustry distribution of employment income discussed in Section 7.2 provides an industry-by-industry account of the local and spillover employment income effects of equalization payments and three conditional grants. This detailed account of the employment income effects generated in a region is aggregated to obtain the regional income distribution effects of federal grants. These income effects indicate the extent to which the benefits from federal grants accrue to recipient and non-recipient regions.

In this section, the regional distribution of employment income effects induced by increased equalization payments and three conditional grants, health grants, social welfare grants, and education grants, are presented. Three per capita local and spillover income effects are reported for each grant:

1. the initial income effect;
2. the IDI income effect; and
3. the IDII income effect.

The regional income distribution effects of a ten dollar per capita increase in equalization payments and conditional grants are reported in Sections 7.3.1 and 7.3.2, respectively.

7.3.1 Equalization Payments

In this section, the per capita local and spillover income effects of a ten dollar per capita increase in equalization payments are reported. These income effects indicate the extent to which recipient and non-recipient regions benefit from increased equalization payments. The dominant pattern of the regional spillovers indicates that Ontario receives the greatest spillovers. The local income effect exceeds the spillover effects of the grant.

The employment income effects of a ten dollar per capita increase in equalization payments to the Atlantic provinces, Quebec, and Manitoba[8] are reported in Table 7.5. Three income effects are reported for each payment. For each income effect, the local and spillover effects are presented. In Table 7.5, columns indicate recipient regions and rows identify the regions where income is generated. Thus, reading down the first column of the table identifies the increase in per capita employment income in each region and in the four Canadian regions as a whole for a ten dollar per capita increase in the equalization payment to the Atlantic provinces. The increase in each region is further decomposed into three income effects while the Canadian total is reported for the IDI and IDII income effects only. Entries in the fourth column of the table indicate the interregional distribution of income resulting from increased equalization payments to the three recipient regions. These estimates of income equal the sum of the first three entries in a row and indicate the employment income which accrues in each region as equalization payments are increased simultaneously in the four Canadian regions. The greatest income effect due to the ten dollar per capita increase in equalization

TABLE 7.5

PER CAPITA EMPLOYMENT INCOME EFFECTS BY REGION OF A TEN DOLLAR PER CAPITA INCREASE IN EQUALIZATION PAYMENTS, 1965

Spillover to	Recipient of Grant			Aggregate Income
	Atlantic	Quebec	Manitoba	
		Initial		
Atlantic	1.34	0.0	0.0	1.34
Quebec	0.0	2.39	0.0	2.39
Ontario	0.0	0.0	0.0	0.0
Manitoba	0.0	0.0	4.17	4.17
United States	0.0	0.0	0.0	0.0
		Initial + Direct + Indirect (IDI)		
Atlantic	3.98	0.10	0.01	4.09
Quebec	0.07	4.70	0.03	4.80
Ontario	0.10	0.39	0.08	0.67
Manitoba	0.03	0.16	5.64	5.83
United States	0.01	0.02	0.004	0.03
Canadian Total	0.58	1.13	0.40	2.11
		Initial + Direct + Indirect + Induced (IDII)		
Atlantic	6.85	0.38	0.02	7.25
Quebec	0.21	6.03	0.05	6.29
Ontario	0.23	0.89	0.11	1.23
Manitoba	0.12	0.55	5.83	6.50
United States	0.08	0.31	0.04	0.43
Canadian Total	0.89	1.82	0.43	2.88

payments occurs in the recipient region. This pattern of local and spill-over income effects is consistent for all three income effects. Each of these per capita income effects is now considered.

The greatest initial income effect, $4.17, occurs in Manitoba. This relatively large initial income effect reflects:

1. the Manitoba government's response to changes in equalization payments; and
2. the large wage value-added component in Manitoba's programs.

Similarly, the order of local IDI income effects reflects the order of the initial income effects. For example, the largest IDI income effect, $5.64, occurs in Manitoba while the smallest IDI effect, $3.98, is reported for the Atlantic provinces. This ranking of local and IDI income effects is in contrast to the ranking of the IDII income effects. The greatest local IDII income effect induced by increased equalization payments occurs in the Atlantic provinces, $6.85. Alternatively, the smallest local IDII income effect from these payments occurs in Manitoba, $5.83. These changes in the ranking of IDI and IDII employment income effects reflect the order of the local grant multipliers (Table 7.5).

Consider the grant multipliers. Two grant multipiers are calculated and presented in Table 7.6: the multiplier without induced income effects, and the multiplier with induced income effects. These grant multipliers measure the additional local employment income which is generated from each additional dollar of initial plus direct employment income created in the region by increased equalization payments.[9] The grant multiplier without induced effects for the Atlantic provinces is 1.36 compared to 1.23 in Quebec, and 1.13 in Manitoba. The same order

TABLE 7.6

LOCAL GRANT INCOME MULTIPLIERS IN EACH REGION
FOR FOUR FEDERAL GRANTS, 1965

Recipient Region	Income Multiplier Without Induced Effects	Income Multiplier With Induced Effects
	Equalization Payments	
Atlantic	1.36	2.35
Quebec	1.23	1.58
Manitoba	1.13	1.17
	Conditional Health Grants	
Atlantic	1.78	2.68
Quebec	2.17	2.89
Ontario	1.41	1.52
Manitoba	1.35	1.40
	Conditional Social Welfare Grants	
Atlantic	1.18	1.71
Quebec	1.37	1.60
Ontario	1.48	1.61
Manitoba	1.31	1.35
	Conditional Education Grants	
Atlantic	1.28	2.15
Quebec	1.13	1.35
Ontario	1.24	1.39
Manitoba	1.18	1.23

is observed for the income multipliers with induced effects: 2.35 in the Atlantic provinces; 1.58 in Quebec; and 1.17 in Manitoba. These multipliers reflect the regional government expenditure <u>and</u> the industrial composition of expenditure generated by increases in equalization payments. For example, in the Atlantic provinces, the major increase in expenditure is on a program with a small wage value-added component, transportation-communication. This is evident in the small initial income effects observed in the Atlantic provinces. Thus, the additional expenditure in the Atlantic provinces is made primarily on produced inputs rather than on primary inputs. This small initial income effect is reflected in the relatively small IDI income effect for the Atlantic provinces. The small IDI income effect in the Atlantic provinces appears to be the result of a small initial income effect rather than a small grant multiplier. The relatively large multiplier with induced effect for the Atlantic provinces is manifested in the IDII income effect for this region. The Atlantic provinces have both the largest IDII income effect and the largest grant multiplier with induced effects. These income effects and multipliers for the Atlantic provinces are in contrast with those for Manitoba. The Manitoba government allocates a large proportion of its increased equalization payment to programs with large wage value-added components; for example, social welfare and other programs. Thus, the initial income effect in Manitoba is relatively large and is dominant in the large IDI income effect despite the relatively small grant multiplier for Manitoba. However, the small multiplier with induced effects in Manitoba is apparent in the low ranking of IDII income effects for this region. Thus, the influence of the initial income effect is outweighed by the grant multiplier effects in these two regions.

Consider the per capita spillover income effects due to the ten dollar per capita increase in equalization payments. These spillovers range from a high of $0.89 in Ontario to a low of $0.004 in the United States. The largest per capita spillovers are generated by payments to Quebec. Furthermore, the largest spillover to the United States, $0.31, is induced by the payments to Quebec. The smallest spillovers are generated by increased equalization payments to Manitoba. The major recipient of these spillover effects is Ontario. The values of the largest spillovers from each region, the IDII income effects, are $0.23 from the Atlantic provinces, $0.89 from Quebec, and $0.11 from Manitoba. These spillovers appear to reflect Ontario's industrial base and dominance in interregional trade.

Estimates of the aggregate per capita income effects, which include both the local and spillover income effects of these payments to a region, are presented in column 4 of Table 7.5. These aggregate income effects indicate the benefits accruing to a region for an increase in the equalization payments to all regions. The largest aggregate income effect, $7.25, occurs in the Atlantic provinces, and the smallest in a recipient region, $6.29, appears in Quebec. For these recipient regions, the local and aggregate income effects are less than the initial increase in equalization payments. This increase in per capita income is due primarily to a local income effect rather than spillover effects from other regions. In the two non-recipient regions, the aggregate IDII income effects are much smaller, $1.23 and $0.43 for Ontario and the United States, respectively.

In addition, the impact of an increase in equalization payments to each region on the per capita IDI and IDII employment income in the four Canadian regions as a whole is presented in Table 7.5. These total income effects are labelled "Canadian total".[10] From these estimates, it appears that the equalization payment to Quebec has the greatest impact on per capita IDI and IDII employment income in Canada, $1.13 and $1.82, respectively. The smallest impact is registered for the payment to Manitoba. The equalization payment to Manitoba has the effect of increasing per capita IDI and IDII employment income in Canada by $0.40 and $0.43, respectively. These differences in per capita income effects are attributed to the differences in total equalization payments to Quebec and Manitoba which are implied by a ten dollar per capita increase in the grant.

In summary, the results in Table 7.5 can be interpreted as follows. Uniform per capita increases in equalization payments have a significant influence on the level of income accruing to labour in each region. This additional income generated in a region originates from two sources: the local income effect and the spillover income effect. Differential local income effects are observed for each equalization payment. Thus, part of the variation in income generated in the recipient region is the result of unique local income effects in each region. In addition, an increase in the equalization payment to one region induces a simultaneous increase in the incomes of all other regions. These spillover income effects are not uniform for all equalization payments. Each grant produces a unique pattern and level of spillovers. Combined with the differential local income effects, these spillovers indicate that significant changes in the regional distribution of employment income are effected.

The differential regional income effects of equalization payments indicate the scope for attaining the regional income distribution objectives defined by the federal government. They demonstrate the efficacy of a regionally discriminating allocation of per capita equalization payments as a means of obtaining these federal objectives. For example, if the federal government wishes to maximize the increase in per capita income in Canada without regard for the regional distribution of these increases, per capita increases in equalization payments should be greatest in the Atlantic provinces. However, this allocation of equalization payments does not minimize the spillover effects of each ten dollar per capita increase in equalization payments. Spillovers from equalization payments are minimized if the grants are directed toward the Manitoba government. The Manitoba government responds to the increased grant by increasing expenditure on programs with high wage value-added components. This response is evidenced by the large initial income effect. Alternatively, an objective of minimizing the differential regional per capita income generated by each ten dollar per capita increase in equalization payments is facilitated by larger increases in the payments to Quebec. However, this allocation of equalization payments maximizes spillovers to the United States. Finally, the largest increase in per capita IDI and IDII employment income in "all of Canada" is generated by the increased equalization payment to Quebec.

Estimates of the interregional income generated by a ten dollar per capita equalization payment to the Atlantic provinces, Quebec, and Manitoba indicate that these grants have selective regional income distribution effects. The equalization payments are redistributive such that recipient regions experience a greater increase in per capita income than do non-recipient regions. This conclusion holds for changes in individual payments and changes in the equalization scheme as a whole. Thus, the federal government can pursue selective granting programs to alter the regional distribution of per capita employment income.

7.3.2 Conditional Grants

In this section, the regional distribution of the per capita regional employment income which is generated by a ten dollar per capita increase in three conditional grants is discussed. Estimates of these income effects are presented in Tables 7.7 through 7.9. The format of these tables is similar to Table 7.5; the first four columns correspond to local and spillover income effects of individual grants, and the fifth column describes aggregate income effects. The employment income effects for each conditional grant are discussed separately.

Health Grants

Consider the regional income distribution generated by a ten dollar per capita increase in the health grant to each region. These grants generate large local and spillover income effects (Table 7.7). The largest of these income effects, \$18.62, which occurs in Manitoba, is twenty-seven percent larger than the second largest income effect, \$14.66, which occurs in Ontario. Quebec gains the least from increases

TABLE 7.7

PER CAPITA EMPLOYMENT INCOME EFFECTS BY REGION OF A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL HEALTH GRANTS, 1965

Spillover to	Recipient of Grant				Aggregate Income
	Atlantic	Quebec	Ontario	Manitoba	
	Initial Income Effect				
Atlantic	8.00	0.0	0.0	0.0	8.00
Quebec	0.0	5.21	0.0	0.0	5.21
Ontario	0.0	0.0	14.66	0.0	14.66
Manitoba	0.0	0.0	0.0	18.62	18.62
United States	0.0	0.0	0.0	0.0	0.0
	Initial + Direct + Indirect Income Effects (IDI)				
Atlantic	14.94	1.01	0.17	0.03	16.15
Quebec	0.15	12.14	1.10	0.13	13.52
Ontario	0.20	1.07	21.00	0.30	22.57
Manitoba	0.10	0.53	1.91	25.61	28.15
United States	0.01	0.06	0.05	0.02	0.14
Canadian Total	2.05	5.11	10.50	1.78	19.44
	Initial + Direct + Indirect + Induced Income Effects (IDII)				
Atlantic	22.50	2.59	0.46	0.09	25.64
Quebec	0.50	16.15	1.83	0.23	18.71
Ontario	0.51	2.61	22.70	0.44	26.26
Manitoba	0.34	1.73	2.46	26.57	31.10
United States	0.18	0.91	0.61	0.16	1.86
Canadian Total	3.30	7.55	10.91	1.95	23.71

in health grants for it experiences the smallest initial income effect, \$5.21. The pattern of IDI and IDII local income effects is identical. Manitoba and Ontario experience the largest local income effects and Quebec gains the least. However, the difference between these income effects is reduced from that which exists between the initial income effects.

The order of the income effects reflects both the size of the wage value-added component in regional government expenditures which are generated by the increased grant, and the amount of this increased expenditure. In Manitoba, which experiences the largest of these income effects, the wage value-added component is large as evidenced by the small health grant income multiplier, 1.40.

The interregional income effects without induced income from increased health grants, described by the IDI spillover effects, emphasize the advantageous position of Ontario. Ontario is the major beneficiary of health grants to all regions. This pattern of spillover is also evident for interregional income effects with induced income. The value of spillovers to Ontario is \$0.51 from the Atlantic provinces, \$2.61 from Quebec, and \$0.44 from Manitoba. In addition, the largest spillover generated by health grants to Ontario, \$2.46, occurs in Manitoba. This pattern of spillovers from health grants reflects the manufacturing base of Ontario, the openness of the regional economies, and the volume of interregional trade motivated by increased government expenditure.

Considering the per capita IDI and IDII employment income in the four Canadian regions as a whole, the smallest income effects are reported in health grants for it experiences the smallest initial income effect, \$3.83. The pattern of IDI and IDII local income effects is identical. Manitoba and Ontario experience the largest local income effects and Quebec gains the least. However, the difference between these income effects is reduced from that which exists between the initial income effects.

The order of the income effects reflects both the size of the wage value-added component in regional government expenditures which are generated by the increased grant, and the amount of this increased expenditure. In Manitoba, which experiences the largest of these income effects, the wage value-added component is large as evidenced by the small health grant income multiplier, 1.40.

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Considering the per capita IDI and IDII employment income in the four Canadian regions as a whole, the largest income effects are reported for the grant to Manitoba, $1.78 and $1.95. These income effects for Manitoba are the smallest reported Canadian totals for all health grants. As in the case of equalization payments, the apparent differences in these income effects are attributed primarily to the differences in the size of each region's total increase in health grants.

The regional income distributions which result from changes in all health grants are described by the aggregate income effects in column 5 of Table 7.7. The pattern of these aggregate income effects is identical to the order of the local income effects for each type of income. The largest aggregate IDII income effect, $31.10, occurs in Manitoba while the smallest, $1.86, occurs in the United States. Thus, these estimates of the income effects of federal health grants indicate that the major portion of aggregate income effects in each Canadian region is made up of the local income effect. However, the spillover effects of this grant create significant variation in regional income.

Social Welfare Grants

Second, consider the regional employment income effects of increased social welfare grants which are presented in Table 7.8. Both the order and magnitude of local and spillover income effects resulting from this grant differ from those generated by increased health grants. However, the spillover effects of this grant remain sufficiently large to influence the per capita employment income in other regions. These income effects are briefly summarized.

As in the case of health grants, the largest initial income effect, $19.12, occurs in Manitoba and the smallest of these effects,

TABLE 7.8

PER CAPITA EMPLOYMENT INCOME EFFECTS BY REGION OF A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL SOCIAL WELFARE GRANTS, 1965

Spillover to	Recipient of Grant				Aggregate Income
	Atlantic	Quebec	Ontario	Manitoba	
Initial Income Effect					
Atlantic	10.79	0.0	0.0	0.0	10.71
Quebec	0.0	4.31	0.0	0.0	4.31
Ontario	0.0	0.0	6.44	0.0	6.44
Manitoba	0.0	0.0	0.0	19.12	19.12
United States	0.0	0.0	0.0	0.0	0.0
Initial + Direct + Indirect Income Effects (IDI)					
Atlantic	18.35	0.42	0.12	0.03	18.92
Quebec	0.12	6.04	0.68	0.13	6.97
Ontario	0.14	0.41	9.78	0.31	10.64
Manitoba	0.09	0.31	0.77	25.46	26.63
United States	0.01	0.02	0.03	0.01	0.07
Canadian Total	2.45	2.48	4.63	1.78	11.34
Initial + Direct + Indirect + Induced Income Effects (IDII)					
Atlantic	26.57	1.01	0.31	0.08	27.97
Quebec	0.48	7.06	1.12	0.23	8.89
Ontario	0.47	0.83	10.69	0.45	12.44
Manitoba	0.35	0.64	1.05	26.32	28.36
United States	0.16	0.25	0.31	0.16	0.88
Canadian Total	3.78	3.14	5.24	1.93	14.09

$4.31, accrues to Quebec. However, the order of the Atlantic provinces and Ontario is reversed. These income effects reflect two characteristics of the expenditure behaviour of each regional government:

1. the fiscal response of the regional government as social welfare grants are increased; and
2. the increased regional government expenditure on direct labour inputs relative to the total increase in regional government expenditure on programs.

For example, the Manitoba government increases its expenditure on two programs with relatively large wage value-added components, social welfare and other programs. This is in contrast to other regional governments which pursue more moderate expenditure increases and increase expenditure on programs which have a larger produced input component.

The order of local IDI and IDII income effects with the exception of Manitoba and the Atlantic provinces, conforms to the order of the initial income effects. The Atlantic provinces experience the largest local IDII income effect, $26.57, while Manitoba has the second largest increase, $26.32. The increase in personal consumption in the Atlantic provinces generates output and further increases in employment income which outweigh the initial income effect in Manitoba. This large induced income effect is illustrated in the grant multiplier with induced effects for social welfare grants to the Atlantic provinces. In general, examination of the federal grant income multipliers indicates that the regional differences in the local IDI and IDII income effects are reduced from the regional differences which exist between initial income effects. The largest multiplier without induced effects and the second largest multiplier with induced effects occur in Ontario.

The interregional income effects of social welfare grants illustrate a pattern of trade different from that generated by health grants. These trade patterns are reflected in both the regional government expenditure patterns and in personal consumption expenditure. For social welfare grants, Quebec receives the largest per capita income spillover with induced effects from grants to two regions. This additional income in Quebec, $0.48 and $1.12, is induced by expenditure in the Atlantic provinces and Ontario respectively. As in the case of health grants, the largest spillover from the social welfare grant to Quebec, $1.01, accrues to the Atlantic provinces. The order of these spillover effects exhibits greater variation than those induced by health grants.

The aggregate impact of the increased social welfare grants to all regional governments on regional income distribution is illustrated in column 4 of Table 7.8. The order of these aggregate income effects, which is identical to the order of local income effects, indicates the relative size of local and spillover effects. Local income effects are significantly larger than spillovers to the same region. Thus, the aggregate income accruing in a region from social welfare grants is primarily attributed to the increase in local income.

As in the case of health grants, the largest per capita IDI and IDII employment income effects in the four Canadian regions as a whole are generated by the social welfare grant to Ontario, $4.63 and $5.24, respectively. The smallest total Canadian per capita employment income effects are generated by the increased social welfare grant to Manitoba, $1.78 and $1.93, respectively. The relative size of these per capita total income effects is attributed primarily to the relative size of the social welfare grants to these two regions.

In summary, the magnitude of local and spillover income effects which are generated by equal per capita increases in social welfare grants to the regions exhibits significant variation. Thus, a different regional income distribution is implied by each social welfare grant.

Education Grants

Finally, consider the per capita employment income effects of a ten dollar per capita increase in education grants which are presented in Table 7.9. The order and magnitude of these local and spillover income effects differ from those induced by other grants. In turn, these unique income effects imply that a unique income distribution can be generated by altering education grants.

Like other grants, the largest initial income effect, \$18.88, occurs in Manitoba. However, unlike other grants, the second largest initial effect, \$11.81, occurs in Quebec and the smallest of these effects, \$4.47, occurs in Ontario. The order of the local IDI and IDII income effects conforms with this ordering of initial effects. This ordering of the local IDI and IDII income effects reflects the relative size of initial income effects rather than the ranking of income multipliers. The smallest employment income multipliers without and with induced effects, 1.18 and 1.23 respectively, are reported for Manitoba. In contrast, the largest multipliers without and with induced effects, 1.28 and 2.15 respectively, occur in the Atlantic provinces. This ranking of income multipliers reflects the reduction of differences in regional employment income effects as induced production and the effects of endogenous personal consumption are worked out.

TABLE 7.9

PER CAPITA EMPLOYMENT INCOME EFFECTS BY REGION OF A TEN DOLLAR PER CAPITA INCREASE IN CONDITIONAL EDUCATION GRANTS, 1965

Spillover to	Recipient of Grant				Aggregate Income
	Atlantic	Quebec	Ontario	Manitoba	
Initial Income Effect					
Atlantic	4.77	0.0	0.0	0.0	4.77
Quebec	0.0	11.81	0.0	0.0	11.81
Ontario	0.0	0.0	4.47	0.0	4.47
Manitoba	0.0	0.0	0.0	18.88	18.88
United States	0.0	0.0	0.0	0.0	0.0
Initial + Direct + Indirect Income Effects (IDI)					
Atlantic	12.67	0.15	0.07	0.03	12.92
Quebec	0.06	18.73	0.35	0.14	19.28
Ontario	0.09	0.95	8.73	0.40	10.17
Manitoba	0.04	0.32	0.39	26.76	27.51
United States	0.01	0.05	0.03	0.02	0.11
Canadian Total	1.68	7.95	4.46	2.16	16.25
Initial + Direct + Indirect + Induced Income Effect (IDII)					
Atlantic	21.25	0.80	0.20	0.09	22.34
Quebec	0.38	22.70	0.61	0.26	23.95
Ontario	0.40	2.42	9.80	0.57	13.19
Manitoba	0.29	1.46	0.57	27.81	30.13
United States	0.14	0.82	0.37	0.21	1.54
Canadian Total	3.04	9.64	4.61	2.09	19.38

Consider the interregional income effects of education grants. The spillover income effects indicate that education grants to a region cannot be increased independently of increasing the per capita employment income in all other regions. The pattern of these interregional income effects reflects the concentration of Canadian manufacturing in Ontario and the dominance of this region in all interregional trade. The largest IDI and IDII spillover income effects generated by education grants accrue to Ontario. The IDII income effects accruing to Ontario range from a high of $2.42 to a low of $0.40. Alternatively, the smallest spillover effects induced by education grants accrue to the Atlantic provinces and the United States. In general, an increase in the education grant to any particular province has a unique impact on the regional income distribution.

The aggregate income effects which describe the per capita employment income expansion in each region generated by equal per capita increases in education grants to all regions are presented in column 4 of Table 7.9. The order of the aggregate income effects follows from the relative magnitudes of local employment income effects. Manitoba and Quebec appear to be the two leading regions. The variation in aggregate employment income effects illustrates the extent that the regional gross income distribution is altered be selective expansion of any education grant.

Consider the per capita IDI and IDII employment income generated in the four Canadian regions as a whole as the education grant to each region is increased by ten dollars per capita. For this grant, the largest per capita total Canadian IDI and IDII employment income effects are generated by the education grant to the Atlantic provinces and Manitoba, respectively. The values of these income effects are $1.68 and $2.09, respectively. Thus, the total Canadian per capita employment income is affected differentially by the education grant to each regional government.

Comparing the income effects of health, social welfare, and education grants, it appears that the expansion of any particular grant has a unique impact on each regional income distribution. This finding suggests that a selective regional economic policy is possible. For example, the greatest local income effect in Quebec and Manitoba is generated by expanding education grants while the social welfare grant and health grant fill this role in the Atlantic provinces and Ontario, respectively. With the exception of Ontario, health grants account for the largest grant multipliers in all regions. In Ontario, the largest multipliers are associated with social welfare grants. Similarly, the greatest spillovers from the Atlantic provinces, Quebec, and Ontario are generated by health grants. In contrast, the greatest spillovers from Manitoba are generated by education grants. The region benefiting most from these spillovers is Ontario.

A specific regional distribution of per capita employment income can be attained through the allocation of federal grants if variation in the local and spillover income effects generated by these grants is significant. For example, if the federal government substitutes a ten dollar per capita increase in social welfare grants for an equal per capita increase in health grants the regional distribution of employment income is altered. This altered regional income distribution is determined by two components: the local and spillover income effects of the grants. Consider the change in the local IDII income effects which is induced by this change in federal grants. In Quebec, local IDII income is reduced by $9.09 compared to a reduction of $12.01 in Ontario, and $6.25 in Manitoba. Alternatively, an increase in income is recorded in the Atlantic provinces. In the Atlantic provinces, the IDII income effect increases by $4.07 as the two conditional grants are changed. These changes in local income effects represent a 56 percent reduction in Quebec, a 53 percent reduction in Ontario, a 1 percent reduction in Manitoba, and a 18 percent increase in the Atlantic provinces.

In contrast to changes in the local income effects, all spillover IDII income effects are reduced as an increase in social welfare grants is substituted for an increase in health grants. The greatest reductions in spillovers are generated by the altered grants to Quebec and Ontario. In the case of the grants to Quebec, the decreases in spillovers are $1.58 to the Atlantic provinces, $1.78 to Ontario, and $1.09 to Manitoba. These decreases represent a 61 percent decrease, a 68 percent decrease, and a 63 percent decrease, respectively, in spillovers generated by grants to Quebec. For Ontario, large decreases are reported for spillovers to Quebec, $0.71, and to Manitoba, $1.41. Three exceptions to this pattern of decreased spillovers are reported. These exceptions involve the change in grants to Manitoba. In this province, spillovers to Quebec and to the United States remain constant while spillovers to Ontario are increased by $0.01.

Finally, consider the change in the aggregate IDII income induced by the substitution of increased social welfare grants for increased health grants in all regions. These changes in aggregate income summarize the regional distribution of local and spillover income effects. For the changes in grants considered here, aggregate IDII income effects in Quebec, Ontario, and Manitoba decrease by \$9.82, \$13.82, and \$2.74 respectively. In contrast, aggregate IDII income effect in the Atlantic provinces is increased by \$2.33. These changes represent a 52 percent reduction in Quebec, a 53 percent reduction in Ontario, a 9 percent reduction in Manitoba, and a 10 percent increase in the Atlantic provinces. Thus, the change in local, spillover, and aggregate IDII income effects induced by the substitution of an increase in health grants for an equal per capita increase in social welfare grants appear to be substantial. Furthermore, substantial variation in local and spillover IDI and IDII employment income effects generated by different grants is recorded.

7.4 Conclusion

In this chapter, the estimated local and spillover employment income effects induced by a ten dollar per capita increase in equalization payments and three conditional grants, health, social welfare, and education, have been presented. Each of the four federal grants generates a unique set of local and spillover income effects at the regional and individual industry levels. Thus, the regional allocation of each type of grant will induce a unique regional and industrial distribution of per capita employment income. A policy designed to stimulate regional government expenditure in general or on specific programs cannot be conducted independent of the redistribution of employment income.

Footnotes to Chapter 7

[1]The assumption of constant investment and federal-provincial taxes and borrowing is restrictive. If investment expenditure were increased, the employment income effects and grant multipliers would be larger than those calculated here. Alternatively, if the increase in federal and provincial taxation or indebtedness which is required to finance the increased grant and grant induced expenditure were included in the model, the calculated employment income effects and grant multipliers would be smaller than those presented here. Therefore, the conclusions reached in this illustrative implementation of the methodology developed in Chapters 4 and 5 must be interpreted with caution.

[2]A ten dollar per capita increase in federal grants implies that the absolute value of the grant differs between regions. Thus, care should be taken in comparing employment income effects which are generated by grants to different regions.

[3]The regional and interindustry ranking of total local and spillover employment income in a region may differ from the ranking of per capita local and spillover employment income. However, per capita employment income effects provide a more accurate indication of the importance of these income effects for the regional economy.

[4]Being more precise, the change in per capita IDI employment income in the rubber and chemical industry in the United States is: \$0.000004, \$0.00002, \$0.000002, from a ten dollar per capita increase in equalization payments to the Atlantic provinces, Quebec, and Manitoba, respectively. The absolute value of these income effects range from a high of \$4,000 to a low of \$400.

[5]These differences in employment income persist even when the absolute value of the increase in equalization payments is equal.

[6]The increase in per capita employment income in the United States rubber and chemical industry is \$0.000009, \$0.00005, \$0.00003, and \$0.000009 for health grants to the Atlantic provinces, Quebec, Ontario, and Manitoba, respectively. The absolute value of these income effects ranges from a high of \$10,000 to a low of \$1,800.

[7]This ranking excludes the zero income effect in the rubber and chemicals industry of the United States.

[8]The Ontario government did not receive an equalization payment in fiscal year 1965.

[9]The grant multiplier without induced income effects for the recipient region is equal to the ratio of:

1. the change in the initial plus direct plus indirect employment income -- the IDI income effect

to

2. the change in the initial plus direct employment income in the region -- the initial plus direct income effect.

The grant multiplier with induced income effects is calculated in a similar way. However, in the computation of the multiplier with induced income effects the IDII employment income effect is substituted for the IDI effect employed in the multiplier without induced effects.

[10]The per capita IDI and IDII Canadian total for each grant is not equal to the sum of the per capita regional IDI and IDII for the same grant. The per capita Canadian total distributes the total increase in employment income over the total population of the four Canadian regions.

CHAPTER 8

CONCLUSIONS AND SUMMARY OF IMPLICATIONS

8.1 Conclusions

This investigation represents an attempt to increase our knowledge of the economic impact of federal grants to provincial governments. The general aim of the study is to develop a methodology appropriate for analyzing the impact of federal grants to regional governments on the interindustry and regional distribution of employment income. The employment income generated in each industry and in each region is shown to differ depending upon the recipient regional government and the type of federal grant. In addition, the empirical implementation of this approach to the analysis of federal grants was illustrated in the development of an empirical calculation of changes in select federal grants in 1965.

The model of the impact of federal grants developed in this study exhibits some notable characteristics. It is an interregional model comprised of two sub-models each emphasizing regional government expenditure disaggregated by program. The first sub-model is a behavioral model of regional government fiscal response to changes in federal grants. The four types of federal grants analyzed are: unconditional grants, conditional non-matching grants, and open- and closed-ended matching grants. Employing this sub-model, federal grant induced changes in regional government expenditure on individual programs are analyzed.

The second sub-model is an interregional I-O model. Two types of I-O models are developed: one in which personal consumption expenditure is exogenously determined, and one in which personal consumption expenditure is endogenously determined. Unlike other interregional I-O models, the industrial composition of regional government expenditure is not assumed to be the same for all programs. Instead, regional government expenditure is disaggregated by program. An individual final demand vector is constructed for each regional government expenditure program. This approach explicitly recognizes that the industrial composition of regional government final demand is different for each expenditure program. Thus, the industrial composition of specific changes in regional government expenditure which is induced by changes in each type of federal grant is determined. These changes in regional government expenditure generate additional employment income in each industry in the recipient region (the local income effect). Clearly, the employment income which is generated in each industry and in each region differs depending upon the variation in fiscal response by recipient governments to the change in federal grants. Furthermore, the income effects of increased federal grants to a regional government are not isolated within the recipient region. Non-recipient regions experience an increase in employment income which is transmitted via the trade links between the non-recipient region and the recipient region (the spillover income effect). These spillover income effects are reported by industry and by region.

In summary, a change in each federal grant generates a unique pattern of regional government expenditure on programs. This unique pattern of expenditure is translated into a unique change in the industrial composition of regional government final demand. Finally, the unique change in the industrial composition of final demand generates a unique interindustry and regional employment income effect in both recipient and non-recipient regions. Changes in taxes are not analyzed.

In general, the differential local and spillover employment income effects which are generated by federal grants are supported in the empirical model. These differences in employment income effects are present at both the interindustry and the aggregate regional levels. These differential income effects appear to represent two influences: first, the unique fiscal response of each regional government to increased federal grants, and second, the unique industrial composition of each program which is included in regional government final demand. In addition, the empirical study indicates that the employment income effects of federal grants extend beyond the recipient region. Some spillover employment income effects of federal grants are significant.

8.2 Summary of Implications of the Results

The approach to the analysis of federal grants developed and empirically implemented in this study increases the present understanding of the interregional and interindustry impact of federal grants to provincial governments. Furthermore, this research has implications for the design of federal grant-in-aid programs to provincial governments. These implications are now summarized.

The results of the study indicate that the employment income effects generated by changes in federal grants to regional governments differ among Canadian regions. In addition, these changes in employment income differ among the industries located in each region. Two forces generate these differential effects:

(1) the fiscal response of each regional government to an increase in federal grants is unique, and

(2) the industrial composition of final demand expenditure by each regional government is unique.

However, several of the empirical relationships are relatively consistent among groups of grants, regions, and industries.

First, consider the pattern of regional government fiscal response to four federal grants discussed earlier. For all regional governments, an increase in equalization payments appears to induce a smaller increase in expenditure than an equal increase in any conditional grant. This difference in fiscal response is attributed to the constraints imposed on regional government expenditure in a conditional grant scheme. Moreover, conditional health grants to all regional governments except the Atlantic provinces appear to induce expenditure on more programs than other conditional grants. These differential effects of federal grants are reflected in the regional government's final demand for goods and services, generating a unique distribution of employment income effects.

The observed employment income which is generated by equal per capita increases in four federal grants to each regional government exhibits some regularity. All federal grants generate spillover employment income effects in non-recipient regions. The pattern of these spillovers has implications for the design of federal grant programs which could accommodate interindustry and interregional distribution of employment income effects.

A notable regularity of the calculated employment income effects is that the per capita local and spillover income effects generated by conditional grants are larger than those generated by equalization payments. In fact, the largest per capita spillovers are generated by conditional health grants. This pattern of per capita spillovers indicates that a federal government which wishes to minimize the interregional spillovers generated by each dollar of federal grants, should place greater emphasis on equalization payments. However, it must be emphasized that the per capita spillovers per dollar of local employment income are greater for equalization payments than for conditional grants.

Ontario receives the largest per capita spillins generated by all federal grants. Thus, the choice of grants will have no impact on preventing Ontario, the most developed region, from receiving the largest share of spillovers. However, it is possible to influence which region receives the smallest spillin. Approximately fifty percent of the smallest per capita spillovers from the four federal grants accrues to the Atlantic provinces. Conditional education and health grants comprise the major share of grants which generate this income distribution. Furthermore, the Atlantic provinces receive the smallest per capita spillovers induced by all grants to Manitoba. The smallest per capita spillovers from the remaining grants accrue to the United States. The pattern of these spillovers indicates that the employment income per grant dollar which flows to the United States may be minimized by emphasizing equalization payments and conditional social welfare grants.

Federal grants to Quebec consistently induce the largest per capita spillovers to other regions. Furthermore, the largest per capita spillovers to the United States are generated by federal grants to Quebec. These large spillovers to the United States reflect one component of the cost which is associated with federal grants to Quebec. Thus, if the federal government wishes to minimize these spillovers then federal grants would have to be shifted away from Quebec.

The same regularities in the regional distribution of employment income are observed, in general, for the interindustry distribution of employment income from federal grants. At an individual industry level, local employment income effects are larger than spillover employment income effects. However, several exceptions to this pattern of income effects arise. For example, spillovers to the leather and textile industry in Quebec and the primary metal industry in Ontario are larger than the local income effects in these industries. A large variation in the size of local and spillover income effects is observed for equal per capita grants of the same type; for example, health grants to different regions. However, this variation in income effects is not reflected in the regional rank of local and spillover income effects for the same type of grant. This large variation in size but not in regional order indicates that:

(1) a specific type of federal grant can be employed to alter the absolute level of employment income accruing to individual industries, and

(2) the grant will not alter significantly the relative level of employment income accruing to select industries in a region.

The use of different types of federal grants, for example health grants *vis-à-vis* education grants, will alter the relative level of employment income which accrues to selected industries in a region. In three regions; the Atlantic provinces, Quebec, and Ontario, the largest local and spillover employment income effects are generated by health grants. The smallest local and spillover employment income effects are generated by equalization payments.

The scope for specific employment income distribution policies employing equalization payments and conditional grants is broad. For example, equalization payments and conditional grants may be allocated to provincial governments such that the resulting distribution of employment income complements the regional industrial growth strategy of the federal government.

The theoretical and empirical models developed in this study are somewhat incomplete. Both models are short run in nature. Increases in regional government expenditure do not influence the level of investment. Furthermore, government taxation and indebtedness to finance the increased federal grants or the increased regional government expenditure are not analyzed. The estimated model of regional government expenditure could be modelled as a system of simultaneous equations. Also, to analyze empirically the effect of each type of grant, federal grants should be disaggregated into more specific categories, for example federal grants for diagnostic health services, hospital construction grants, etc. The empirical I-0 model should be expanded to include I-0 sectors for Saskatchewan, Alberta, and British Columbia. Further theoretical and empirical work appears warranted for all components of the behavioral model of fiscal response and the interregional I-0 model. These limitations are a topic for future research.

Despite these shortcomings, this research is valuable. A methodology appropriate for analyzing the interregional employment income effects of intergovernmental grants is presented. This methodology is employed to illustrate the extent to which Canadian federal grants to provincial governments generate employment income in non-recipient provinces. With this information which specifies the regional and interindustry distribution of employment income, federal grant programs may be designed to neutralize the effects of these spillovers or to employ more effectively the spillover effects of federal grants.

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Appendix A

DISPLAY OF SELECT INTERREGIONAL I-O MATRICES

For ease of reference, select matrices of the interregional I-0 models are presented in this appendix. The dimensions of each matrix is printed under the schematic representation. First, consider the interregional trade coefficient matrix $\underline{\underline{T}}$.

$$\underline{\underline{T}} = \left[\begin{array}{ccc|ccc|c|ccc}
t_1^{11} & & 0 & t_1^{12} & & 0 & & t_1^{1m} & & 0 \\
 & \ddots & & & \ddots & & \cdots & & \ddots & \\
0 & & t_n^{11} & 0 & & t_n^{12} & & 0 & & t_n^{1m} \\
\hline
t_1^{21} & & 0 & t_1^{22} & & 0 & & t_1^{2m} & & 0 \\
 & \ddots & & & \ddots & & \cdots & & \ddots & \\
0 & & t_n^{21} & 0 & & t_n^{22} & & 0 & & t_n^{2m} \\
\hline
 & \vdots & & & \vdots & & & & \vdots & \\
\hline
t_1^{m1} & & 0 & t_1^{m2} & & 0 & & t_1^{mm} & & \\
 & \ddots & & & \ddots & & \cdots & & \ddots & \\
0 & & t_n^{m1} & 0 & & t_n^{m2} & & & & t_n^{mm}
\end{array}\right]$$

$(mn \times mn)$

Second, consider the $\hat{\underline{\underline{A}}}$ matrix of Input-Output coefficients.

$$\hat{\underline{\underline{A}}} = \left[\begin{array}{ccc:ccc:c:ccc}
a^1_{11} & \cdots & a^1_{1n} & & & & & & & \\
\vdots & & \vdots & & 0 & & \cdots & & 0 & \\
a^1_{n1} & \cdots & a^1_{nn} & & & & & & & \\ \hdashline
& & & a^2_{11} & \cdots & a^2_{1n} & & & & \\
& 0 & & \vdots & & \vdots & \cdots & & 0 & \\
& & & a^2_{n1} & \cdots & a^2_{nn} & & & & \\ \hdashline
\vdots & & & & \vdots & & \ddots & & \vdots & \\ \hdashline
& & & & & & & a^m_{11} & \cdots & a^m_{1n} \\
& 0 & & & 0 & & \cdots & \vdots & & \vdots \\
& & & & & & & a^m_{n1} & & a^m_{nn}
\end{array}\right]$$

(mn x mn)

Next, the matrix of average propensities to consume out of personal disposable income, $\hat{\underline{\underline{c}}}$, is presented.

$$\hat{\underline{\underline{c}}} = \left[\begin{array}{c:c:c:c}
b^1_1 & & & \\
\vdots & 0 & \cdots & 0 \\
b^1_n & & & \\ \hdashline
& b^2_1 & & \\
0 & \vdots & \cdots & 0 \\
& b^2_n & & \\ \hdashline
\vdots & \vdots & \ddots & \vdots \\ \hdashline
& & & b^m_1 \\
0 & 0 & \cdots & \vdots \\
& & & b^m_n
\end{array}\right]$$

(mn x m)

Other final demand coefficients are given in the $\hat{\underline{\underline{F}}}'$ matrix. This matrix is schematically presented below.

$$
\hat{\underline{\underline{F}}}' = \left[\begin{array}{ccc|ccc|c|ccc}
f_{11}^{1'} & \cdots & f_{K1}^{1'} & & & & & & & \\
\vdots & & \vdots & & 0 & & \cdots & & 0 & \\
f_{1n}^{1'} & & f_{Kn}^{1'} & & & & & & & \\
\hline
 & & & f_{11}^{2'} & \cdots & f_{K1}^{2'} & & & & \\
 & 0 & & \vdots & & \vdots & \cdots & & 0 & \\
 & & & f_{1n}^{2'} & & f_{Kn}^{2'} & & & & \\
\hline
\vdots & & & & & & \ddots & & & \vdots \\
\hline
 & & & & & & & f_{11}^{m'} & \cdots & f_{K1}^{m'} \\
 & 0 & & & 0 & & \cdots & \vdots & & \vdots \\
 & & & & & & & f_{1n}^{m'} & \cdots & f_{Kn}^{m'}
\end{array}\right]
$$

(mn x mK)

Next, consider the mn x mf block diagonal matrix of regional government final demand coefficients.

$$
\hat{\underline{\underline{G}}} = \left[\begin{array}{ccc|ccc|c|ccc}
g_{11}^{1} & \cdots & g_{1f}^{1} & & & & & & & \\
\vdots & & \vdots & & 0 & & \cdots & & 0 & \\
g_{n1}^{1} & \cdots & g_{nf}^{1} & & & & & & & \\
\hline
 & & & g_{11}^{2} & \cdots & g_{1f}^{2} & & & & \\
 & 0 & & \vdots & & \vdots & \cdots & & 0 & \\
 & & & g_{n1}^{2} & \cdots & g_{nf}^{2} & & & & \\
\hline
\vdots & & & & & & \ddots & & & \vdots \\
\hline
 & & & & & & & g_{11}^{m} & \cdots & g_{1f}^{m} \\
 & 0 & & & 0 & & \cdots & \vdots & & \vdots \\
 & & & & & & & g_{n1}^{m} & \cdots & g_{nf}^{m}
\end{array}\right]
$$

(mn x mf)

The regional government final demand vector constructed for the Keynesian-Leontief I-O model, $\underline{\tilde{G}}$, is presented schematically.

$$\underline{\tilde{G}} = \begin{bmatrix} g_1^1 \\ g_2^1 \\ \vdots \\ g_n^1 \\ w_G^1 \\ \hdashline g_1^2 \\ g_2^2 \\ \vdots \\ g_n^2 \\ w_G^2 \\ \hdashline \sim \\ \hdashline g_1^m \\ g_2^m \\ \vdots \\ g_n^m \\ w_G^m \end{bmatrix}$$

The output and personal disposable income vector, $\underline{\tilde{X}}$, is displayed below.

$$\underline{\tilde{X}} = \begin{bmatrix} x_1^1 \\ x_2^1 \\ \vdots \\ x_n^1 \\ \nu^1 \\ \hline x_1^2 \\ x_2^2 \\ \vdots \\ x_n^2 \\ \nu^2 \\ \hline \sim\!\sim \\ \hline x_1^m \\ x_2^m \\ \vdots \\ x_n^m \\ \nu^m \end{bmatrix}$$

The regional government unconditional grant allocation matrix is presented as a mf x m block diagonal matrix, $\hat{\underline{\underline{H}}}_{GU}$.

$$
\hat{\underline{\underline{H}}}_{GU} = \left[\begin{array}{c|c|c|c}
\begin{matrix}\eta_1^1 \\ \vdots \\ \eta_f^1\end{matrix} & 0 & \cdots & 0 \\
\hline
0 & \begin{matrix}\eta_1^2 \\ \vdots \\ \eta_f^2\end{matrix} & \cdots & 0 \\
\hline
\vdots & \vdots & \ddots & \vdots \\
\hline
0 & 0 & \cdots & \begin{matrix}\eta_1^m \\ \vdots \\ \eta_f^m\end{matrix}
\end{array}\right]
$$

(mf x m)

The regional government allocation matrices for

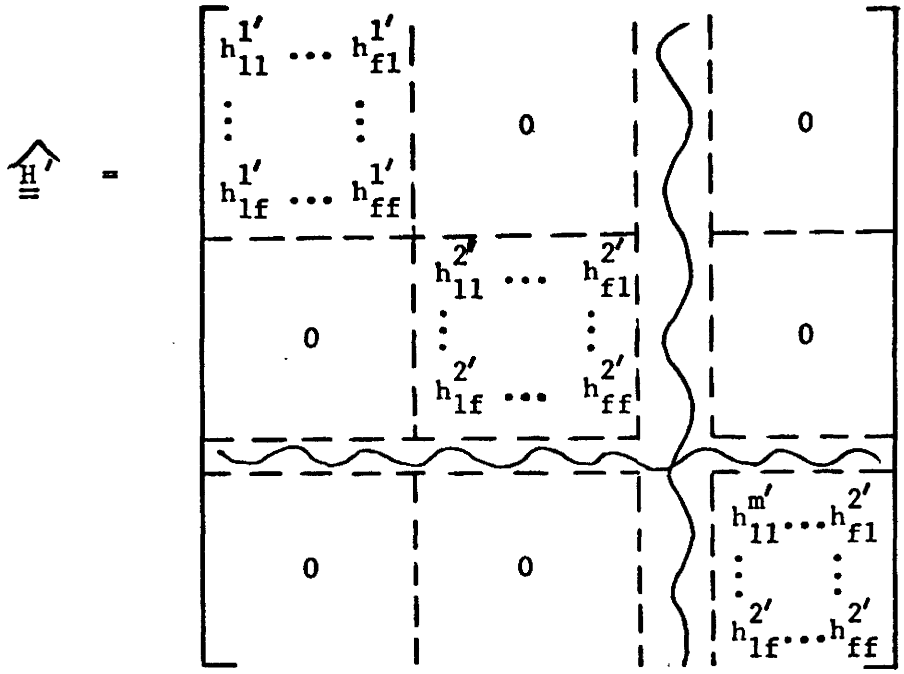
1. open-ended matching grants, $\hat{\underline{\underline{H}}}'_{PO}$,

2. changes in the grant limit of a closed-ended matching grant, $\hat{\underline{\underline{H}}}'_{GC}$,

3. changes in the matching ratio of a closed-ended matching grant, $\hat{\underline{\underline{H}}}'_{PC}$, and

4. conditional non-matching grants, $\hat{\underline{\underline{H}}}'_{GN}$

are mf x mf block diagonal matrices. Each block on the diagonal of these matrices is a f x f matrix. Similarity in the format of these matrices facilitates presentation of a general schematic figure to illustrate their structure. This figure is presented below as the $\hat{\underline{\underline{H}}}'$ matrix. In this schematic figure, the general element $h_{KJ}^{k'}$ replaces elements specific to any of the four matrices listed above.



(mf x mf)

The four value-added matrices,

1. wage value-added coefficients for I-0 sectors, $\hat{\underline{\underline{V}}}_X$,
2. wage value-added coefficients in personal consumption final demand, $\hat{\underline{\underline{V}}}_N$,
3. wage value-added coefficients in each service provided by regional governments $\hat{\underline{\underline{V}}}_G$, and
4. wage value-added coefficients in other final demand, $\hat{\underline{\underline{V}}}_Z$

are presented below.

$$\hat{\underline{\underline{V}}}_X = \begin{bmatrix} a^1_{w1} \cdots a^1_{wn} & 0 & \cdots & 0 \\ 0 & a^2_{w1} \cdots a^2_{wn} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & a^m_{w1} \cdots a^m_{wn} \end{bmatrix}$$

(m x mn)

$$\hat{\underline{\underline{V}}}_N = \begin{bmatrix} w^1_C & & & 0 \\ & w^2_C & & \\ & & \ddots & \\ 0 & & & w^m_C \end{bmatrix}$$

(m x m)

$$\hat{\underline{\underline{V}}}_G = \begin{bmatrix} w^1_1 \cdots w^1_f & 0 & \cdots & 0 \\ 0 & w^2_1 \cdots w^2_f & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & w^m_1 \cdots w^m_f \end{bmatrix}$$

(m x mf)

$$\hat{\underline{\underline{V}}}_Z = \left[\begin{array}{c:c:c:c} w_1^1 \cdots w_J^1 & 0 & \cdots & 0 \\ \hdashline 0 & w_1^2 \cdots w_J^2 & \cdots & 0 \\ \hdashline \vdots & \vdots & \ddots & \vdots \\ \hdashline 0 & 0 & \cdots & w_1^m \cdots w_J^m \end{array}\right]$$

As the format of all other vectors employed in describing the I-0 models is straightforward, they are not represented schematically in this appendix.

FIGURE 5-1

THE INTERREGIONAL INCOME ACCOUNTING SYSTEM

		Consuming Industries 1 2 n ... mn	Personal Consumption 1 ... m	Regional Government 1 ... m	Other Final Demand 1 ... m	Row Sum
Producing Industries	1	$x_{11}^{11}\ x_{12}^{11} \dots x_{1n}^{11} \dots x_{1j}^{1k} \dots x_{1n}^{1m}$	$c_1^{11} \dots c_1^{1m}$	$g_1^{11} \dots g_1^{1m}$	$f_1^{11} \dots f_1^{1m}$	X_1^1
	2	$x_{21}^{11}\ x_{22}^{11} \dots x_{2n}^{11} \dots x_{2j}^{1k} \dots x_{2n}^{1m}$	$c_2^{11} \dots c_2^{1m}$	$g_2^{11} \dots g_2^{1m}$	$f_2^{11} \dots f_2^{1m}$	X_2^1
	⋮	⋮ ⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮
	n	$x_{n1}^{11}\ x_{n2}^{11} \dots x_{nn}^{11}$ ⋮ ⋮	$c_n^{11} \dots c_n^{1m}$	$g_n^{11} \dots g_n^{1m}$	$f_n^{11} \dots f_n^{1m}$	X_n^1
	⋮	$x_{i1}^{r1} \dots x_{ij}^{rk} \dots x_{in}^{rm}$	$c_i^{r1} \dots c_i^{rm}$	$g_i^{r1} \dots g_i^{rm}$	$f_i^{r1} \dots f_i^{rm}$	X_i^r
	mn	$x_{n1}^{m1} \dots x_{nj}^{mk} \dots x_{nn}^{mm}$	$c_n^{m1} \dots c_n^{mm}$	$g_n^{m1} \dots g_n^{mm}$	$f_n^{m1} \dots f_n^{mm}$	X_n^m
Income from Employment	1	$w_1^1\ w_2^1 \dots w_n^1\ 0 \dots 0$	$w_c^1 \dots 0$	$w_{G1}^1 \dots 0$	$w_f^1 \dots 0$	W^1
	2	$0\ 0 \dots 0\ w_1^2 \dots 0$	$0\ w_c^2 \dots 0$	$0\ w_{G2}^2 \dots 0$	$0\ w_f^2 \dots 0$	W^2
	⋮	⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮ ⋮	⋮
	m	$0\ 0 \dots 0 \dots w_n^m$	$0 \dots w_c^m$	$0 \dots w_{Gm}^m$	$0 \dots w_f^m$	W^m
Taxes on Expenditure Less Subsidies	1	$T_1^1-s_1^1\ T_2^1-s_2^1 \dots T_n^1-s_n^1 \dots 0$	$T_c^1-s_c^1 \dots 0$	$T_G^1-s_G^1 \dots 0$	$T_F^1-s_F^1 \dots 0$	$T_E^1-s_E^1$
	⋮	$0\ 0 \dots 0\ T_1^2-s_1^2 \dots 0$	$0\ T_c^2-s_c^2 \dots 0$	$0\ T_G^2-s_G^2\ 0$	$0\ T_F^2-s_F^2 \dots 0$	$T_E^2-s_E^2$
	m	$0\ 0 \dots 0\ 0 \dots T_n^m-s_n^m$	$0 \dots T_c^m-s_c^m$	$0 \dots T_G^m-s_G^m$	$0 \dots T_F^m-s_F^m$	$T_E^m-s_E^m$
Other Primary Inputs	1	$v_1^1\ v_2^1 \dots v_n^1\ 0 \dots 0$	$0 \dots 0$	$0 \dots 0$	$0 \dots 0$	V^1
	⋮	$0\ 0 \dots 0\ v_n^2 \dots 0$	$0\ 0 \dots 0$	$0 \dots 0$	$0 \dots 0$	V^2
	m	$0\ 0 \dots 0\ 0 \dots v_n^m$	$0 \dots 0$	$0 \dots 0$	$0 \dots 0$	V^m
Column Sum		$X_1^1\ X_2^1 \dots X_n^1\ X_1^2 \dots X_j^k \dots X_n^m$	$C^1 \dots C^m$	$G^1 \dots G^m$	$F^1 \dots F^m$	$= \sum_{k=1}^{m}\left(\sum_{i=1}^{n} X_i^k + C^k + G^k + F^k\right) = \sum_{k=1}^{m}\left(\sum_{i=1}^{n} X_i^k + W^k + T_E^k - s_E^k + V^k\right)$

APPENDIX B

ESTIMATED REGIONAL GOVERNMENT EXPENDITURE EQUATIONS

In this appendix, the estimated model of regional government fiscal response to federal grants is discussed. Four items are discussed in detail: specific demographic variables and the relationship between these variables and regional government expenditure, a description of the data on personal income and unconditional grants, the estimation procedure, and the estimated equations.

First, consider the demographic variables employed in this model. Five demographic variables which describe each region are included in the model: population density, the extent of urbanization, the percent of the population between 20 and 64 years of age, the percent of the population between 5 and 19 years of age, and the number of automobiles registered per 1000 persons. Each of these variables is now considered.

Population density: as in most empirical studies of this nature, population density is employed to reflect the effects of economies of scale. Economies of scale are experienced in the provision of goods and services by the public sector as population density increases initially. However, further increases in population density may lead to crowding and diseconomies of scale. Thus, no consensus has been reached in the literature concerning the expected relationship between population density and regional government expenditure (Maley, 1972, pp. 126-127). As the degree of crowding may vary for each type of program and between regions, no expectation is formed concerning the expected sign of the population density variable in the regression equations.

Extent of urbanization: in most empirical studies of local and provincial government expenditure, it is assumed that government expenditure per capita is higher in urban areas than in rural areas. Implicitly, this approach assumes that rural residents are more self-sufficient and require fewer government goods and services than do urban residents, and that costs are greater in urban areas, e.g., the cost of land is greater in urban areas than in rural areas (Maley, 1972, p. 126). These assumptions indicate that regional government expenditure is expected to be positively related to the degree to which the region is urbanized.

Percent of population between 20 and 64 years of age: health and social welfare programs are generally directed more to young and old persons than to persons of working age, e.g., persons between 20 and 64 years of age. Thus, the percentage of population of working age is included in the expenditure equations for health and social welfare programs. This variable is expected to be negatively related to regional government expenditure on health and social welfare programs (Maley, 1972, pp. 127-128).

Percent of population between 5 and 19 years of age: it is generally observed that the greater is the proportion of the population which is of school age, e.g., persons between 5 and 19 years of age, the greater is the per capita expenditure on education. The percent of population which is of school age is included in the education expenditure equation only. This variable is expected to be positively related to the per capita expenditure on education by a regional government (Maley, 1972, p. 127).

Automobile registrations per 1000 persons: this variable is included only in the transportation-communication program expenditure equation. The number of automobile registrations per 1000 persons is expected to have a positive influence on regional government transportation expenditure.

The remaining variables included in the regression equations, federal grants and the cost variable, are described in Section 6.2.1 of Chapter 6.

Second, consider the data on personal disposable income net of federal taxes and unconditional grants.

Personal income per capita net of federal taxes: ideally, this variable should be total regional income net of federal taxes. However, the only income series available by region are personal disposable income and personal income. Neither of these is completely satisfactory for the purposes of this analysis as they exclude all business savings and indirect taxes. Personal income net of federal taxes is approximated by adding regional direct taxes to personal disposable income in the region (Maley, 1972, p. 122).

Unconditional grants: because of numerous changes in the federal-provincial fiscal arrangements between 1947 and 1965, it is difficult to properly define unconditional grants. Here, unconditional grants are defined as the total value of transfers from the federal government to regional governments without conditions on the regional government's use of these funds. Thus, pure tax rental payments are included in unconditional grants (Maley, 1972, p. 116).

Next, consider the estimation procedure and the equations estimated for the behavioral model of regional government fiscal response to federal grants, 1947-1965. The form of the estimated expenditure functions is best explained by reiterating the primary objectives of this aspect of the study. This empirical analysis provides estimates of the elements in the I-0 fiscal response matrix $\hat{\underline{\underline{H}}}_2'$ which are not available from other sources. To satisfy the requirements of this empirical model, all the economic variables which describe federal grants to each regional government are included in the equations regardless of their statistical significance.

Equations (6.1) and (6.2) are first estimated by OLS including all economic and demographic variables reported by Maley (1972). In general, these equations are unsatisfactory. Many regression coefficients are not significant because of multicollinearity in the independent variables.

Consequently, the combination of independent variables which maximized the adjusted coefficient of determination, the $\bar{R}^2$ statistic, is selected. This equation is referred to as the "best equation". The exclusion of independent variables is based on two criteria:

1. the significance of the beta coefficients according to the two-tailed t-test, and
2. the overall significance of the equation as measured by the F-statistic.

In all cases, the beta coefficients of the excluded variables are insignificant at the 5 percent level and the overall significance of the equation increased after their exclusion.

Economic variables which were excluded in step two are then combined with the variables from the "best equation" to form an "augmented best equation". This "augmented best equation" is estimated by OLS. All variables describing federal grants are included in the regression analysis to obtain estimates of the elements in the fiscal response matrices, $\hat{\underline{\underline{H}}}_1$ and $\hat{\underline{\underline{H}}}_2'$. The list of variables included in the "augmented best equation" is presented in Table B.1. The "augmented best equations" are presented in Table B.2.

The salient features of each estimated expenditure function are now summarized. All the expenditure function equations are significant according to the F-statistic, with R^2 values ranging from 0.72 for expenditure on transportation-communication services in the Atlantic provinces to 0.99 for expenditure on health services in Manitoba. Regional government expenditures on transportation-communication services are most poorly explained for all regions except Ontario where natural resource-primary industry development expenditures are most poorly predicted (R^2 = 0.98).

TABLE B.1

NAME AND DEFINITION OF VARIABLES INCLUDED IN REGRESSION EQUATIONS

Variable Name	Definition
HLTH	Per capita health expenditure
SW	Per capita social welfare expenditure
ED	Per capita education expenditure
TRC	Per capita transportation-communication expenditure
OE	Per capita expenditure on all other regional programs
Y^k	Per capita personal income net of federal taxes in region
G^k	Per capita unconditional grants to regional government
CHG	Per capita conditional health grants
CSWG	Per capita conditional social welfare grants
CEG	Per capita conditional education grants
CTCG	Per capita conditional transportation-communication grants
CNRG	Per capita conditional natural resource-primary industry grants
POP	Population density
URB	Extent of urbanization
WRKAGE	Percent of Population between 20 and 64 years of age
SCHAGE	Percent of population between 5 and 19 years of age
MVR	Automobile registrations per 1000 persons
WA	Average weekly wages and salaries
DNF	Dummy variable for Newfoundland
DNS	Dummy variable for Nova Scotia
DPE	Dummy variable for Prince Edward Island
T	Time

TABLE B.2

ESTIMATED EXPENDITURE EQUATIONS FOR FIVE REGIONAL GOVERNMENT EXPENDITURE PROGRAMS IN FOUR CANADIAN REGIONS

Equation Number	Estimated Equation	R^2	DW	F
	Atlantic Provinces			
(1)	HLTH = -5.1023 - .0006Y - .1078G^k + 1.8026 CHG + .0704 CSWG + .0668 CEG + .1389 CTCG (11.6364) (.0086) (.0598) (.1428) (.1895) (.1252) (.0669) + .5587 CNRG + .3462 WA + .0194 T + 9.0626 DNF + 4.1698 DPE. (.6408) (.2881) (.7320) (4.1384) (2.6402)	.98	2.47	241
(2)	SW = 90.0316 + .0305 Y + .0814 G + .0734 CHG + 1.3187 CSWG + .0162 CEG + .0136 CTCG (40.5684) (.0083) (.0362) (.0966) (.1111) (.0762) (.0457) + .6110 CNRG - .1951 POP + .5734 URB - 2.2127 WRKAGE - .4304 WA - .9995 T (.3854) (.2242) (.1992) (.9179) (.1689) (.6882) + 2.9845 DNF + 13.5094 DPE. (3.6149) (8.3845)	.97	1.85	128
(3)	ED = -186.0972 + .0308 Y + .0499 G + .0157 CHG + 1.0084 CSWG + 1.4530 CEG + .0849 CTCG (54.7300) (.0125) (.0621) (.1581) (.2004) (.1286) (.0726) - .2676 CNRG + 3.0223 POP + .7417 URB + 1.6256 SCHAGE + 1.1956 WA - 4.0118 T (.6543) (.9893) (.4549) (1.1365) (.3405) (1.2105) + 39.6589 DNF - 54.8584 DPE - 36.4011 DNS. (12.4262) (22.7523) (14.1455)	.97	.91	
(4)	TRC = 82.3282 + .0151 Y + .4618 G - .9810 CHG + .3827 CSWG + .8203 CEG + .4751 CTCG (30.6111) (.0421) (.1815) (.5543) (.6369) (.4401) (.2279) + 1.5015 CNRG - .6489 URB - 1.5918 WA + 5.1041 T - 19.8991 DPE. (2.3986) (.5246) (.5328) (1.9169) (10.7428)	.73	2.48	14
(5)	OE = -6.393 + .012 Y + .150 G + .20 CHG + .717 CSWG - .057 CEG + 1.158 CTCG (14.926) (.314) (.171) (.42) (.528) (.354) (.188) + 1.478 CNRG - 9.404 DNF - 1.164 DPE - 4.062 DNS (1.947) (8.976) (5.057) (4.789)	.85	2.71	26

TABLE B.2 (Continued)...

	Quebec			
(1)	HLTH = 85.9015 + .0032 Y^k + .0410 G^k + 1.0295 CHG − .0773 CSWG − 1.2196 CEG (57.7512) (.0038) (.1029) (.1753) (.2355) (.8426) + 4.1844 CTCG + 17.1646 CNRG − 1.5399 WRKAGE. (2.4352) (5.8391) (1.0508)	.99	1.91	608
(2)	SW = −43.8941 − .0026 Y^k + .1478 G^k − .2175 CHG + .8076 CSWG + .0682 CEG (6.3016) (.0030) (.0801) (.1155) (.1412) (.4914) −1.3205 CTCG + 11.3139 CNRG + 7.5058 POP. (1.4209) (3.434) (1.2183)	~~.99~~	1.78	576
(3)	ED = −8.5769 + .0199 Y^k + .6391 G^k + .6337 CHG − .4496 CSWG + 2.5139 CEG (4.1602) (.0035) (.1529) (.2658) (.4111) (1.5537) −3.8656 CTCG + 24.7027 CNRG. (4.5574) (10.5859)	.99	1.47	297
(4)	TRC = −378.2713 − .0142 Y^k − .4524 G^k − .4541 CHG + .1560 CSWG − .0435 CEG (241.6528) (.0178) (.5015) (.5121) (.8789) (2.2379) + 4.1154 CTCG + 1.9695 CNRG + 52.0777 POP + 2.7295 WA − 15.5512 T. (6.7107) (15.0039) (35.3434) (1.9176) (9.8659)	.96	2.39	21
(5)	OE = −15.283 − .0009 Y^k − .032 G^k − .440 CHG + .195 CSWG + 2.276 CEG − .439 CTCG (3.588) (.005) (.127) (.212) (.289) (.893) (.893) +17.146 CNRG + .506 WA. (6.204) (.130)	.99	2.39	344

TABLE B.2 (Continued)...

Ontario

(1)	HLTH = 2.9362 + .0052 Y^k + .0213 G^k + 2.1197 CHG - .3491 CSWG + 1.1760 CTCG (7.0172) (.0041) (.1743) (.1264) (.4807) (.4576) + 1.8981 CNRG + .0736 CEG (3.6325) (.1082)	.99	2.51	522
(2)	SW = 1.4738 + .0018 Y^k - .0200 G^k + .0833 CHG + 1.1665 CSWG - .0594 CEG + .2492 CTCG (1.7628) (.0010) (.0438) (.0318) (.1208) (.0272) (.1150) + 4.9250 CNRG. (.9125)	.99	1.73	271
(3)	ED = 15.7771 + .0036 Y^k + .0050 G^k + .1493 CHG + .2411 CSWG + 1.1144 CED - .9435 CTCG (53.2696) (.0057) (.1733) (.3363) (.4044) (.0951) (.7363) + 17.3944 CNRG - 2.9199 URB + 8.3981 SCHAGE + .1772 WA. (4.3075) (1.7675) (3.4233) (.2368)	.99	2.23	575
(4)	TRC = 179.7627 - .0128 Y^k - .0958 G^k - .4399 CHG - .5765 CSWG - .2334 CEG (122.0161) (.0121) (.4185) (.4353) (1.2011) (.2081) 2.5045 CTCG + 10.2979 CNRG - 13.2539 POP - .1954 MVR + .3102 WA + 8.7013 T. (1.6159) (10.6244) (10.1324) (.2014) (1.4424) (5.4329)	.98	2.01	26
(5)	OE = 1.084 - .008 Y^k - .188 G^k + .245 CHG + .189 CSWG - .005 CEG + .368 CTCG (4.499) (.004) (.115) (.092) (.297) (.664) (.466) + 11.066 CNRG + .583 WA. (2.400) (.105)	.99	2.52	373

TABLE B.2 (Continued)...

	Manitoba			
(1)	HLTH = 213.201 + .00000002 Y^k - .1568 G^k + 2.0705 CHG + .0822 CSWG + .4754 CEG (234.375) (.00000001) (.0676) (.0755) (.1457) (.3650) + .3020 CTCG + .1493 CNRG + 3.4745 T - 3.9393 URB. (.2686) (.1881) (3.2226) (4.4322)	.99	2.79	2858
(2)	SW = -60.5462 - .00000001 Y^k + .3258 G^k + .2235 CHG + 1.5800 CSWG + .4064 CEG (26.7974) (.00000001) (.1004) (.0945) (.1991) (.4536) -.2169 CTCG - .5056 CNRG + 24.8058 POP - .4331 WA. (.3103) (.1733) (11.5208) (.2256)	.99	2.66	106
(3)	ED = 691.7244 + .00000001 Y^k + .2028 G^k + 1.5135 CHG + .6401 CSWG + 4.4787 CEG + (231.3843) (.00000005) (.4216) (.3424) (.8443) (1.4775) 1.9267 CTCG - .4491 CNRG - 237.7461 POP + 12.8413 T. (1.0467) (.5474) (77.9129) (4.0514)	.99	2.11	75
(4)	TRC = 260.5238 - .000000004 Y^k - .5047 G^k + .3968 CHG - .1548 CSWG - 1.3647 CEG (148.9818) (.0000008) (.5584) (.5252) (1.1069) (2.5160) + 3.4648 CTCG + .9937 CNRG - 123.6992 POP + 3.0788 WA. (1.7250) (.9636) (64.0503) (1.2544)	.92	1.96	12
(5)	OE = -112.96 - .000005 Y^k + 0.80 G^k + 0.47 CHG + 2.53 CSWG - 2.92 CEG - 3.29 CTGT (35.84) (.000005) (.32) (.33) (.67) (1.58) (1.11) -1.21 CNRG + 1.96 URB. (.59) (.65)	.97	2.69	37

Standard errors are in brackets below the regression coefficients.

APPENDIX C

TRADE COEFFICIENT DATA

In this appendix, the source of interregional trade data employed in the AERC interregional I-O table is presented. These data are discussed at an aggregate industry grouping.

Agricultural sector trade coefficients are obtained from data published by the Canadian federal and provincial governments for 18 agricultural commodities. Initial coefficients established for ten provinces and the U.S.A. are adjusted to reflect estimates of the movement of agricultural commodities by the AERC. The final stage of computing agricultural trade coefficients involves a weighted aggregation of commodity dollar flows and provinces to form regional coefficients (Appleton, 1973, p. 25).

The forestry sector trade coefficients are calculated from data supplied to the AERC by the Federal Department of Environment and Statistics Canada.

As most provinces impose restrictions on the inter-provincial movement of raw forest products, the AERC has a high degree of confidence in the accuracy of these coefficients (Appleton, 1973, p. 26).

Trade coefficients for the fish and fur industry are calculated by the AERC from inter-provincial flow data provided by the Federal Department of the Environment and Statistics Canada (Appleton, 1973, p. 26). These data are in the form of the dollar-value of the fish and fur industry trade.

Mineral sector trade coefficients are derived from data on the top ten mineral commodities which accounted for 97% of total Canadian mineral production. These estimates are then extrapolated to approximate total mineral flows. Calculations are initially made for the ten provinces. Inter-provincial flows are then aggregated over commodities and provinces. Flow data on mineral commodities were acquired from the Federal Department of Energy, Mines and Resources (Appleton, 1973, p. 26).

Trade coefficients for the Manufacturing sectors of the AERC model are obtained from the 1966 Statistics Canada survey of total value of factory shipments of goods of own manufacture and goods not of own manufacture by province in which the purchaser or transferee branch is located and shipments to buyers or branches in other provinces and countries (Statistics Canada 31-504.) The data which the AERC used when calculating trade coefficients are based on inter-provincial shipments by all establishments whose major activity is manufacturing, as well as their direct shipments to other countries. Some of the Statistics Canada data is confidential; therefore, the AERC estimates inter-provincial flows for these industries. The industries for which data estimation is necessary comprise only 9.2% of the total manufacturing sector, thus only minimal estimation error is introduced into the I-0 model (Appleton, 1973, pp. 26-27).

Trade coefficients for the service sectors of the AERC model are estimated from provincial accounts and provincial I-0 tables. These initial estimates are then adjusted to reflect 1967 economic conditions (Appleton, 1973, p. 27).